UNIVERSITÉ D'OTTAWA ÉCOLE DES GRADUÉS

PRODUCTIVITY TRENDS IN CANADIAN MANUFACTURING INDUSTRIES, 1946-1964

by Pierre J. Gosselin

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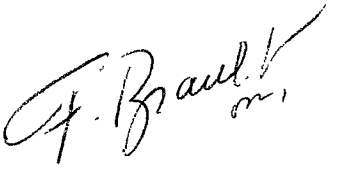

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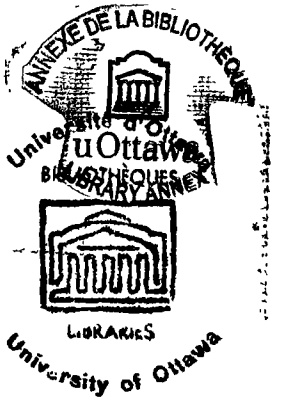

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CURRICULUM STUDIORUM

Pierre J. Gosselin was born August 23, 1940, at Ottawa, Ontario. He received his Bachelor of Commerce Degree in 1964 from the University of Ottawa and sat for his comprehensive examination in July of 1965.

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INTRODUCTION

Although a substantial amount of work has been done in productivity research using a single factor input, little has yet been written using the "total factor" concept. The term "total factor" refers to the technique used to derive productivity ratios which are based on a combination of labour and fixed capital estimates which are weighted according to the market value of their services. To date, the most important contribution in this area is contained in J. W. Kendrick's book, Productivity Trends in the United States. [1]

The total factor productivity estimates for the Canadian manufacturing sector are presented and analysed in this thesis. They are arrived at largely by using the concepts developed by J. W. Kendrick in his study of the American economy.

Productivity ratios which do not take account of all factor inputs are not useful for the measurement of over-all changes in productive efficiency since they can be affected by changes which may occur in the combination of inputs, i. e. by factor substitutions. The "total factor" concept was chosen for use in this thesis since it uses both labour and capital in the construction of the input estimates thus ruling out changes in productivity arising from factor substitutions. Using this method

1 John W. Kendrick, Productivity Trends in the United States, (Princeton, Princeton University Press, 1961), p. LII, 630.

only those factors which are proper to productivity will influence the industry estimates.

The method of estimating fixed capital stock was provided by the work of Wm. C. Hood and Anthony Scott in, Output, Labour and Capital in the Canadian Economy. [2] Actual estimates of fixed capital were published by the Dominion Bureau of Statistics in Preliminary Estimates of Fixed Capital Flows and Stocks, Canada, 1946-1960. [3]

The basic concept of labour input utilized in this thesis is that of labour time. This can be expressed in terms of hours worked or hours paid. From a standpoint of defining a purely physical relationship between output and input, man-hours worked would seem to be the most appropriate concept since it relates the physical output to a measure of the man-hours expended in its creation. The data required to present estimates based on this concept are not available for the period prior to 1958, therefore in the interest of comparability, man-hours paid were used.

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2 Wm. C. Hood and Anthony Scott, Output, Labour and Capital in the Canadian Economy, (Ottawa, Queen's Printer, 1957), p. 512.

3 Canada, Dominion Bureau of Statistics, Preliminary Estimates of Fixed Capital Flows and Stocks, Canada, 1946-1960, (Ottawa, D. B. S. Daily Bulletin, Tuesday Dec. 22, 1964).

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Information on employment, wages and salaries, and hours was taken from the following Dominion Bureau of Statistics publication: General Review of the Manufacturing Industries of Canada,[4] and Earnings and Hours of Work in Manufacturing.[5]

The major problems encountered in deriving the estimates stem from the fact that the data used was collected for purposes other than the calculation of productivity. As a result of the Dominion Bureau of Statistics' changes in definitions and industry classifications it was frequently necessary to make adjustments to ensure the comparability of the data over the period under consideration.

The capital stock estimates produced by the Dominion Bureau of Statistics did not extend beyond 1960. It was therefore necessary to produce preliminary estimates for the 1960-1964 period in order to obtain the needed coverage in all industries.

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4 Canada, Dominion Bureau of Statistics, General Review of the Manufacturing Industries of Canada, (Ottawa, Queen's Printer, Annual).

5 Canada, Dominion Bureau of Statistics, Earnings and Hours of Work in Manufacturing, (Ottawa, Queen's Printer, Annual).

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Indexes of "total factor" productivity were produced at the industry level and aggregated and weighted to derive estimates for the manufacturing sector as a whole. This was done to ensure the comparability between industry and sector estimates. The industry classification chosen for this thesis is that of the 1949 Census of Manufacturers and all prior and subsequent classification changes were adopted to conform with the chosen list.

The primary purpose of this thesis is to derive estimates of productivity for the Canadian manufacturing sector using the "total factor" concept and to assess their meaning. The estimates derived cover the period from 1946-1964 and were produced at both the industry and sector levels. The analysis of the estimates so derived sets out the demensions of the growth of productivity over the relevant period as well as its distribution among the individual industries in an effort to reveal the trends which may exist in the data. The influence of cyclical factors on these variables has also been investigated and analysed.

In recent years, productivity has gained increasing acceptance among labour, business and government as a tool in collective bargaining. On the one hand, it has been utilised to justify wage demands and on the other as a basis for income policies. With this in mind the

Canadian experience was reviewed in an effort to examine the possible relationship between the changes in productivity and the changes in real wages and salaries.

The Economic Council of Canada has also investigated the behaviour of real wages and productivity but it has done so with the aim of focussing on the factors influency the growth of productivity. Once these factors have been established the Council recommends various courses of action designed to increase productivity.

> Rising productivity, is at one and the same time, the indespensible condition for the achievement of rising standards of life and a powerful factor in the circumstances required to ease the possible strains and conflicts among the various aims and purposes of our increasingly complex society. In addition to enlarging incomes, improvements in productivity are important for increasing profitability and competitiveness of Canadian industry, for better interregional balance, for providing growing resources for social purposes and for maintaining a viable balance of payments. [6]

The use of productivity indexes as a tool in collective bargaining is examined with a view to determining the feasibility of such a course of action and to examine some of the possible limiting factors of such a policy.

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6 Canada, Economic Council of Canada, Second Annual Review Towards Sustained and Balanced Growth, (Ottawa, Queen's Printer, December 1965), p. 169.

CHAPTER I

THE SIGNIFICANCE OF PRODUCTIVITY

1. The Development of Interest in Productivity.

Economists have long been concerned about the effect of technological advances on economic development. Adam Smith gave expression to this concern for productivity when he wrote:

> The annual produce of the land and labour of any nation can be increased in its value by no other means, but by increasing either the number of its productive labourers, or the productive powers of those labourers who have been employed... in consequence either of some addition and improvement to those machines and instruments which facilitate and abridge labour; or of a more proper division and distribution of employment. [1]

During much of the XIX century, the importance of productivity to economic development continued to be recognized but the implications drawn from this relationship led economists to different conclusions. David Ricardo and John Stuart Mill were pessimistic in that they felt that increases in population growth would outstrip the benefits to be derived from productivity. On the other hand, Henry C. Carey, John Rae and Henry George believed that economic expansion would be characterized by increases in productivity rather than by diminishing returns.

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1 Adam Smith, An Inquiry into the Nature and Causes of the Wealth of Nations, (New York: Random House, 1937), p. 326.

The representatives of the neo-classical school were not completely free from Malthusian fears, but as Marshall stated in his "Principles of Economics", the danger of stagnation did not appear to be imminent.

The term 'productivity' itself was first used regularly in the marginal productivity theory of value. This theory related the value of the marginal product to the value contributions of the primary factors of production, and attempted to account for the division of the value produced among the factors. This doctrine soon became entangled with ethical concepts, and was used to determine the 'right' or 'proper' way of distributing the surplus value created.

One very basic weakness of all these theories was the lack of empirical evidence to test them. This deficiency was corrected only relatively recently. During recent years, the increasing interest in questions of economic growth, cost-structure and international competitiveness and in the relationship between output, employment, earnings and prices has focussed attention on productivity as a framework within which such problems can be usefully analysed.

2. The Productivity Concept.

The term 'productivity' is generally used rather broadly to denote the ratio of output to any or all associated inputs, in real terms. [2]

In this sense, there exists a whole range of productivity ratios, each of which indicates the savings achieved in particular cost elements over time as a result of changes in productive efficiency and factor substitutions. Productivity ratios which utilize a single factor input are termed 'partial productivity' measures, and the most common such ratio is output per man-hour.

Until recently, most of the productivity measures that have been developed related output to a single primary input, namely labour. The main reasons for the widespread use of labour as the denominator in productivity ratios are that: a) labour is a resource common to all industries; b) labour, in the majority of cases, accounts for the largest part of value added in the productive process; c) labour is the consumer as well as the producer of the economy's goods and services, and therefore increases in output per unit of labour provide a means of increasing the standard of living, and d) it relates

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2 John W. Kendrick, Productivity Trends in the United States, (Princeton, Princeton University Press, 1961), p. 6.

production to one of the scarcer factors, i. e. human resources. The use of labour as the common denominator of productivity ratios does not mean, of course, that the 'productivity' so measured is solely the result of the human factors involved; rather, these ratios imply that compared to the common yardstick of labour input, the relative output is so much for has changed by so much.

Productivity ratios which do not take account of all factor inputs are not useful for the measurement of over-all changes in productive efficiency since they can be affected by changes which may occur in the combination of inputs, i. e. by factor substitutions.

> Underlying the estimation of output-input relations stands the concept of the production function, i. e., the notion that the physical volume of output depends on the quantities of productive services, or inputs, employed in the production process and the efficiency with which they are utilized. [3]

In the national accounts framework, the output of the economy as a whole is generally measured in terms of the final products only. Intermediate inputs consumed in the productive process are removed through consolidation of the accounts to eliminate double counting. The inputs associated with the national product reduce to the services of the factors of production, which can usefully be classified as human and non-human.

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3 Ibid., p. 6.

In the accounts prepared by individual firms, output is frequently measured gross, i. e., no deductions are made for intermediate purchases. In this case the relevant inputs consist of the factor inputs plus the intermediate - product inputs. In order to arrive at real product estimates by industry these intermediate product inputs must be netted out to arrive at a value added estimate by industry of origin. This done, the estimates of industry output reflect the services of the basic factors, as in the economy case.

Changes in the productivity of tangible factors cannot be measured directly. Approximations are possible by comparing the real output to time-flow measures of the real inputs utilized in the creation of these products. Since the significance of the ratios is largely dependent on the exact content of the constituent elements, the concepts and measures employed in their derivation will be discussed in greater detail in subsequent chapters.

> At this point however, it is apparent that the productivity measure reflects, to an important extent, the excluded input of the tangible capital accumulated in order to increase the efficiency, i. e. the productive capabilities, of the tangible factors. But this and other qualitative elements cannot be independently measured in a satisfactory way. [4]

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4 Ibid., p. 7.

Another feature of production theory which should be noted is that the composition of outputs as well as inputs varies over time. Such changes in factor combinations invalidate the use of partial productivity ratios in the measurement of changes in productive efficiency. This holds even if the input is a major cost element, eg. labour input. However, these partial productivity ratios can be quite useful in the measurement of the savings realized over time in the use particular inputs. This fact becomes increasingly manifest if the ratio is inverted to read 'input per unit output'. Here a declining ratio is evidence of the savings achieved in the use of a particular input factor. However, it should be noted that these partial productivity ratios are affected by factor substitutions and the labour savings achieved may in fact be the result of increased use of capital or of a general increase in productive efficiency.

In order to measure the true savings realized in the use of factor inputs and thus the increase in overall productive efficiency it is necessary to compare the output to all inputs employed in its creation. This, then is the measure of productivity that this thesis will seek to establish for the Canadian manufacturing sector over the relevant period.

3. The Meaning of Productivity Change.

> Total factor productivity may be thought of as the ratio of real product in the manufacturing sector or in component industries (at constant unit factor cost) to the associated real national income deflated by factor prices. [5]

If output and input units of a later period (II) are deflated by the costs and prices of base period (I), then changes in the ratios can be interpreted as follows:

> We are comparing what the outputs of period II would have cost at the factor prices and unit factor requirements of period I (real output) with what they did cost in constant period I factor prices but at period II level of efficiency (real input). [6]

In other words we are comparing the real output of period II with what it would have been if the period I level of efficiency had prevailed. Thus, the increase or decrease so determined can be attributed to changes in productivity.

Total factor productivity is affected not only be technical change or innovation, reflecting advanced know-how as brought to bear by the entrepreneur on the production processes; it is also influenced by variations in the scale of production. The rate of utilization of capacity chiefly affects productivity over the business cycle since it can be shown that for any combination of units of fixed capital found in a plant there is an optimum rate of utilization. Substantial departures from this norm will result in increasing costs per unit output thus affecting our measures

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5. Ibid., p. 10.
6. Ibid., p. 11.

of productivity. If we base our analysis of productivity on estimates for 'key years' (i. e. years of relatively high economic activity), we can minimize the effect of changing rates of utilization. An alternative method would be to use a moving average to eliminate the cyclical influence.

Finally, it should be noted that by measuring inputs in terms of their base period compensation, which under competitive conditions tends to approximate their marginal revenue productivity (i. e., the revenue produced by the sale of the output attributable to the marginal factor), we are neglecting changes in the services of immaterial capital accumulated in order to increase the efficiency of resources in future periods. This immaterial capital consists mainly of the technical knowledge of individuals accumulated by investment in research and education and its services are manifested through the application of this newly acquired technical ability by individuals in productive activity, or through the instruments of production. Since the measurement of the changes brought about by the application of this intangible capital would have to be approached in terms of the savings in real costs achieved through the application of greater productive knowledge; then, the productivity index is the necessary first approximation to the measurement of the 'missing' factor.

To the extent that interindustry differentials in factor remunerations reflect differences in intangible capital and its services per unit of input, relative shifts of factors towards higher paying industries result in an increase in real input associated with the intangible investment required to adopt factors to more productive uses. To this extent, our aggregate input estimates do reflect increasing quality of inputs. In other words, the weighting of manhours will catch some of this intangible capital in the productivity estimate for the

manufacturing sector as a whole, since the labour in industries with high rates of pay are given more weight than that in low pay industries. However, the procedure of weighting is only a step in the right direction. All the labour within an industry is still assumed to be homogeneous. Perhaps more important, broad advances in education are not taken into account because these very often are not directly related to the cost structure of the industry. Also, it should be noted that differences in labour quality are imperfectly measured by pay differentials, since these are influenced by such other factors as the non-economic advantages and disadvantages of particular occupations, differences in the cost of living as between geographic areas, the relative bargaining power of particular trade unions, and uncompleted adjustments to changes in demand and supply. Therefore it can be said that the use of weighted measures of labour input will reflect the direction but not the degree of bias associated with changes in the quality of labour.

4. Uses and Limitations of Productivity Estimates.

Productivity measurement can serve as an aid in wage and price determination. The question of how to share the fruits of production between labour, management and the consumer, has for a long time been a central issue of economic and political thought. Both labour and management want an equitable share of the fruits of the productive process, but views as to what constitutes 'equitable' differ widely as between employer and employee. Wage bargaining

and collective bargaining is usually fought more on the basis of strength than on the basis of economic principles, although economic arguments have been quoted by both sides in support of their case. Nonetheless, an objective guidepost is usually missing.

Gradually it has come to be realized that the results of wage bargaining have deep effects on the general economic conditions, and extend far beyond the two bargaining parties, mainly by affecting the price level and thereby the consumer's real income. As inflationary pressures became more pronounced in the postwar period, the need for an effective guide, which would help the bargainers attain their goals without contributing significantly to inflation, became more evident. For if inflation should result from excessive wage demands, acceded to by management under pressure, both sides might lose on the one hand what they had gained on the other. In this regard it was of lesser significance wether most price increases had been caused by demand-pull or cost-push factors.

Attention was focussed upon productivity as a possible solution. Firstly, increased productivity is the reason for the existence of an additional piece of economic pie that can be divided between labour, entrepreneur and consumer. Secondly, it was held by some economists that in the long run the increases in real hourly wages were closely related to output per man-hour measures of productivity.

In the light of these considerations the idea of using productivity estimates to indicate to what extent wages could increase without having inflationary consequences appeared attractive. The first intentional use of this approach was built into the 1948 collective agreement signed by General Motors of Canada Ltd., allowing for an 'annual improvement factor' which was closely tied to the long-term rate of growth of productivity. During the Korean War period many other collective agreements included various kinds of escalator clauses, partly tied to productivity. Unions are generally in favour of using productivity as a guide in bargaining, but they strongly oppose any rigid formula because that might imply their acceptance of a fixed labour-share of the national product.

In view of the detrimental effects of inflation, governments have also taken an interest in the relationships of productivity to wages, prices and employment. In his 1959 report, President Eisenhower stated that:

> The terms of agreements reached between labour and management in wage and related matters will have a critical bearing on our success in attaining a high level of economic growth with stable prices... Increases in money wages and other compensation not justified by the productivity performance of the economy are inevitably inflationary. [5]

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5 U.S., National Archives and Records Service, Public Papers of the Presidents: Dwight D. Eisenhower 1959, p. 118-119.

Statements of this nature have been repeated year after year. President Kennedy's 1962 report referred to the 'Guideposts' for non-inflationary wage increases, prepared by the Council of Economic Advisers. The new 'Guideposts permitted more latitude and they recognized that in a free economy, wages, profits, and relative prices have a function to perform in the movement of labour and capital from one industry or sector to another. This meant that the basic direct relationship between wages and productivity must, therefore, be modified by a number of provisos.

Critics of the 'Guideposts' and of any other similar use of productivity ratios for collective bargaining, point out that such rules freeze the workers' share of national income and may result in wider fluctuations in labour cost and business cycles. The critics also emphasize that the increase in output per man-hour may have been caused by factor substitution and that in fact there is no extra pie to divide. Some of these objections can be answered by devising more appropriate productivity measures which will allow for factor substitution and by using trend values rather than year - to - year estimates as guides, thus eliminating some of the cyclical influences.

In conclusion, we may say that the use of productivity measures in wage bargaining serves an important purpose, by providing a general guide as to the total combined real net gain in wages, profits and prices at the national level. But productivity measures only show how much bigger the pie is, not how it should be divided.

Productivity and Competition

Our competitive position in the international market will depend to a great extent on the price and related cost of our products as well as their quality. Relative productivity, being a major cost determinant, is therefore a major factor of our success in foreign trade.

In this regard, the question is often asked how Canadian producers, with their high wage rates, can compete in countries that have low wage rates or with products originating in these countries. The question is not a simple one but discussion of some relevant factors may throw some light on a possible solution. Firstly, wage rates are not equal to unit labour costs. If our productivity is high, the unit labour costs will be relatively low, even when wages are high. Secondly, labour costs may not be a large part of total costs. In summary, high wages do not necessarily put us into an unfavourable competitive position. Thus, the nation as a whole must try to produce those goods in which its productivity is higher than in other industries compared to its international competitors. This implies a gradual shift towards specialization in our more productive industries along with generally higher real wages and increasing standard of living. In this way we can import those goods where our comparative advantage, taking account of both our resources and our productivity, is smallest; while on the other hand, in industries where we are highly productive, we should be able to compete even in low-wage countries.

At the level of the firm, a lack of success in competing with foreign products should lead management to take a closer look at their productivity, particularly if other domestic competitors are able to compete internationally.

Individual firms are beginning to make use of productivity estimates as a management tool. This growing awareness of productivity at the company level is being expressed through comparisons with the historical record or with the performance of similar firms in other countries. These comparisons can also be made between individual plants with a single company and reveal unfavorable trends before they become evident in the financial statements and they may point to possible solutions.

Productivity and Economic Growth

Perhaps the most convincing reason that productivity measurement should be a central issue of any study of economic growth, is that historically most of the increase in the output of the economy originated from increases in productivity. The real national product can grow on account of three causes: more persons employed, more hours worked and more output per unit input. Since, according to American data, the effect of the growth of the employed labour force was largely offset by the shortening of the working hours, the whole additional per capital real output was due to increased productivity.

It is therefore natural for students of economic growth to turn to measures of productivity to obtain assistance and information on such matters as the rate of growth and its determinants. Such information can then be used to explain past experience and is of material aid in projecting future developments.

Limitations

> Certain limitations on the use of productivity measures must also be noted. Such measures are not precision tools of analysis, but are subject to unknown and probably not inconsequential margins of error. Their meaning must be interpreted carefully in the light of knowledge as to their construction... They are clearly not 'all-purpose' indexes, but must be used in conjunction with other measures in order to assess progress in the broader realms of social and economic efficiency as contrasted with the narrower realm of technological efficiency. [6]

Since productivity indexes are subject to error and are sometimes erratic, users of these measures should be cautioned against attaching great importance to small changes in the estimates especially when these are measured on a year to year basis. In these matters it is wise to limit analysis to trend values where due consideration has been given to the choice of appropriate

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6 Kendrick, loc. cit., p. 17.

base years. The user of such estimates would also give a great deal of attention to the concepts used in their construction so as not to arrive at fallacious inferences of causality.

Users of productivity measures must guard against confusing productivity with production or capacity measures. Total factor productivity indexes provide a measure of the effectiveness with which the factors of production are being used as of a point of time or over a period of time, but they do not provide information on the potential efficiency of these same resources under conditions of optimum use and allocation. This then explains the emphasis that has been placed on the remouval of cyclical influences which account for most of the wastes involved in lapses from full employment positions.

Measures of productivity do not provide an index of 'economic efficiency'. Economic efficiency, according to Tibor Scitovsky, is production which conforms with the community's wishes while technological efficiency is "the achievement of the greatest possible output with given means or the achievement of given output with smallest means". 9

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9 Tibor Scitovsky, Welfare and Competition, (Homewood, Illinois, Irwin, 1951), p. 148.

Therefore total factor productivity will not yield us any information on whether or not the various factors of production are being employed in an optimum fashion from the point of view of 'economic efficiency'.

> Changes in economic efficiency affect productivity measures only indirectly. Over long periods in a dynamic economy with as much economic freedom and mobility as prevails in the United States, the gains to be realized from tightening up economic efficiency are probably minor compared with those that accrue from increases in technological efficiency, which are primarily reflected in the productivity measures. [10]

Nevertheless, a continuing awareness of economic efficiency and the fostering of policies designed to promote economic efficiency remain important objectives.

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10 Kendrick, loc. cit., p. 18.

CHAPTER II

OUTPUT

In this chapter, the concepts underlying the estimates of real output used will be discussed with a view to illustrating some of the problems and limitations associated with the chosen measure. Alternate measures of output will be compared in order to arrive at the most suitable measure of output for the purpose at hand. Finally, the growth of real output in the manufacturing sector will be discussed, and this analysis may well prove useful when the input estimates are treated.

1. Alternative Measures of Output.

One of the most familiar measures of output is that given in the National Accounts, i.e., Gross Domestic Product at Factor Cost. Estimates of G.D.P. are given in official Dominion Bureau of Statistics publications. Each sector's contribution to the domestic product is arrived at by adding together the rewards of the factors of production employed in that sector. Output as measured by G.D.P. excludes the indirect taxes less subsidies applied to the products of that sector and also excluded, by convention, is the depreciation on capital employed in that sector.

A second measure of output is that of net value added as defined in the census of industry. Here the output of manufacturing industries is defined as the difference between the value at current market prices of the goods and services produced in the current period, less the value of intermediate inputs

measured at current costs. Thus, the measure of output in the Canadian census of industry is essentially a measure of the value added to the intermediate material and service inputs by the application of labour, entrepreneurship, capital and a few services. Net value added as expressed in the census of industry includes the depreciation on capital as well as such intermediate services as advertising, insurance and transportation. This measure of output is expressed in current dollars and thus reflects current prices.

The third measure of output to be examined is the index of industrial production which has been published in Canada since 1935. The original index covered only the power, mining and manufacturing industries. Recently the index of industrial production has been expanded to include the output originating in forestry, fishing and trapping, construction, agriculture, transportation, storage and communication, finance, insurance, real estate, wholesale and retail trade, public administration and defence, community, business recreation and personal service industries. The objective of the index of industrial production is to measure, in real terms, the change in the volume of output of an industry, output being defined as the difference between the value of goods and services produced and materials, fuel, power and the services of advertising, insurance and transportation purchased. Therefore from the conceptual viewpoint, the index of industrial production

should include depreciation and exclude indirect taxes, subsidies, services as well as other intermediate inputs purchased from other industries. In practice, it is not possible to exclude intermediate service inputs in this way because the basic data is lacking. Other difficulties associated with this measure will be discussed below when this measure is treated in detail.

The adequacy of the measures of output described depends primarily on the use to which they are put. The aforementioned output estimates will now be discussed with respect to a few important characteristics.

Ideally, any measure of output should provide information for a fairly detailed breakdown of industries and their components. The output of an industry as measured by national income accounts does not meet these requirements. The industrial contributions to national income as published in Canada are available only for broad sectors of the economy; for example, and this is particularly relevant in this study, no breakdown of the manufacturing sector is provided. Output measures defined as net value added according to the census of industry) and those defined by the indexes of industrial production provide very fine breakdowns for the manufacturing sector but this is not necessarily true for all other sectors of the economy.

For the purposes of this thesis it is desirable that the measure of output utilized be in real terms and thus insensitive to changes in the general price level. If this requirement were not met then a decline in the purchasing power of a monetary unit, e. g. the dollar, might be misconstrued as a growth in output. This requirement can only be met if the measure of output is expressed in physical units or constant dollars. Industrial

contributions to national income are, as we have stated earlier, measures of output in terms of the income generated through the creation of that output.

> It is almost as difficult in practice as it is in theory to deflate a series of income figures. Presumably it would not make much sense to seek to measure output with series of income figures corrected for changes in the prices of goods a consumer buys. On the other hand, if we seek to deflate figures of income received by each factor of production, we find that while we have rather obvious deflators - wage and salary rates - for the income of wage earners, the selection of deflators for profits, rent rates and interest receipts is much more difficult. [1]

Net value added, as defined in the census of industry, measures output in current dollars.

> It is almost impossible to correct this measure for price change as it includes a complex of incomes, depreciation and payments for other business services. [2]

The index of industrial production by virtue of its construction, is independent of price changes. It is a volume index weighted according to the prices prevailing in the chosen base period. However, this measure of output is affected by the changing structure of prices since products with relatively high unit prices in the base year get correspondingly high weights in the index.

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1 Wm. C. Hood and Anthony Scott, Output, Labour and Capital in the Canadian Economy, Royal Commission on Canada's Economic Prospects, (Ottawa, Queen's Printer, 1957), p. 205.

2 Ibid., p. 205.

Therefore, if the price structure for certain commodities undergoes fairly drastic changes this can have marked effect on the validity of the measure of output.

The measure of output chosen must also take account of changes in inventories since profits and losses on inventories cannot be regarded as output. When the output of an industry is measured by its contribution to national income, profits for the industry will include inventory profits unless a specific adjustment is made for their exclusion. In the National Accounts such adjustments are made only with respect to grain stocks.

Net value added as defined by the census of industry and the index of industrial production also require such adjustments since they are constructed using data based on the value of factory shipments. Such adjustments, as are possible, are made in the case of the index of industrial production.

In summary, output as measured by Gross Domestic Product is inadequate for our purposes because it is almost impossible to express it in constant dollars, it is not available in a fine industrial breakdown and because this measure lacks an inventory valuation adjustment.

Output as measured by net value added is also inadequate for our purposes since it uses current prices and is therefore highly sensitive to price fluctuations. This measure is also very difficult to express in real terms using available deflators.

The indexes of industrial production are available for a detailed industrial breakdown and are independent of price fluctuations. This measure of output is attractive for our purposes because it is a volume measurement and is based on the same sources as the input measurements. Although these indexes are defficient in many respects, as will be seen later, they are nonetheless the best of the three measures thus far explored and very considerable use will be made of them.

2. GDP at Factor Cost.

> In developing estimates of overall physical output of goods and services by industry, the objective is to measure the concept of Gross Domestic Product at Factor Cost. In National Accounts terminology, this is equal to Gross National Product at Market Prices less indirect taxes, plus subsidies and adjusted for interest and dividends paid to and received from non-residents. [3]

On an industry basis what is being measured is the output of industries located in Canada, not the output of factors resident in Canada, hence domestic product rather than national product. Gross domestic product can be derived

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3 Canada, Dominion Bureau of Statistics, Revised Index of Industrial Production, 1935-1957, (Ottawa, Queen's Printer, 1959), p. 12.

from gross national product by subtracting factor shares received by Canadian residents from foreign countries and by adding factor shares paid to non-residents.

In measuring the contribution of each industry to gross domestic product the objective is to show the allocation of total resources in the process of production. However, if taxes and subsidies are not excluded they will tend to distort the relative contribution of industry factors of production. Moreover, it is desirable to make industry weights invariant to any changes in indirect taxes and subsidies especially since the weighting system is fixed for the period under review. This therefore is the rationale for using the concept of factor cost rather than market price. Gross domestic product at factor cost equals gross domestic product at market prices less indirect taxes plus subsidies.

The inclusion of capital cost allowances makes the concept of Domestic Product 'gross'. If these allowances are subtracted the product is said to be 'net' since it is measured after allowance has been made for the replacement of the capital used up in the process of production through wear and tear and obsolescence.

> Moreover, statistical difficulties involved in the seperate measurement of capital consumption allowances by industry make it more feasible to restrict the industry estimates to the gross concept rather than attempt to measure net product originating in each industry. [4]

The inclusion of capital cost allowances in the output estimates precludes the use of a net concept of capital stock in the denominator of the productivity ratio because this would tend to produce an upward bias in our productivity estimates.

The derivation of G.D.P. at factor cost in current dollar terms, at the industry level, can be effected in two different ways. It can be arrived at by summing the factor costs and capital consumtpion allowances of each industry or it may be derived by subtracting intermediate input costs from the industry's gross value of output. In the industry approach to G.D.P. as measured in constant dollar terms, it is impossible to use the first method since deflators for such factor inputs as profits and other investment incomes are not available.

> Thus, for purposes of deriving constant dollar industry indexes, the most feasible approach to the desired measure is through the subtraction of intermediate material and service inputs valued at base period prices from total or gross output also valued at base period prices. [5]

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4 Ibid., p. 12.

5 Canada, Dominion Bureau of Statistics, Indexes of Real Domestic Product by Industry of Origin, 1935-61, (Ottawa, Queen's Printer, 1963), p. 37.

In the industry of origin approach the ideal situation would be one where it would be possible to trace, on an industry-by-industry basis, the value added to particular commodities or services. However since most industries produce a complex of products and services and that individual plants are so organized that many intermediate inputs cannot be assigned to specific products or processes then this ideal method of calculating G. D. P. is not feasible. This data limitation dictates that gross domestic product at factor cost can only be measured at the industry level.

Ideally real net output should be measured by deducting from real gross output the value of the intermediate material and service inputs expressed in real terms. These estimates could then be expressed in index form and base weighted according to the industry's contribution to G. D. P. in the base year. In practice, in Canada, strict adherence to this ideal has been precluded by data limitations and several types of indicators were used to approximate real output. The types of indicators used and their importance in the index of manufacturing production are set out in Table I.

TABLE I

TYPES OF INDICATORS

INDEX OF MANUFACTURING PRODUCTION

	Percentage share of G.D.P. originating in 1949
Type of annual or bench-mark index:	
Net output	44.2
Gross output	28.7
Gross value deflated	12.2
Materials used	8.8
Materials deflated	4.3
Employment	1.8

Source: Revised Index of Industrial Production, 1935-1957, Dominion Bureau of Statistics, p. 25.

Each of the above indicators will be briefly described below. Additional information on the use of these indicators by industry groups and sub-groups is available in the Revised Index of Industrial Production, 1935-1957, Dominion Bureau of Statistics, (Ottawa, Queen's Printer, 1959), and in the Indexes of Real Domestic Product by Industry of Origin, 1935-1961, Dominion Bureau of Statistics, (Ottawa, Queen's Printer, 1963).

Net Output

The volume of Gross Domestic Product originating in each industry is considered to be the ideal measure of output for the purpose at hand. However at present data difficulties preclude the development of such a series although much effort is being expended in the development of close approximations. The concept which at present most closely approximates the concept of G. D. P. originating is 'value added'.

In order to measure 'value added' data on both the quantity and value of final products, materials used, and fuel and electricity consumed are required. These statistics are collected by the Census of Manufacturing for a considerable number of industries.

Each of the above indicators will be briefly described below. Additional information on the use of these indicators by industry groups and sub-groups is available in the Revised Index of Industrial Production, 1935-1957, Dominion Bureau of Statistics, (Ottawa, Queen's Printer, 1959), and in the Indexes of Real Domestic Product by Industry of Origin, 1935-1961, Dominion Bureau of Statistics, (Ottawa, Queen's Printer, 1963).

Net Output

The ideal measure of output for each industry is the volume of G.D.P. originating. As explained previously, it is not at present possible to develop such series perfectly although much effort is being expended in the development of close approximations. The indicator which comes closest to measuring the concept of G.D.P. originating is 'value added'.

The measurement of 'value added' requires statistics on both the quantity and value of products, materials used, and fuel and electricity consumed. These data are collected by the Census of Manufacturing for a considerable number of industries.

The technique of measuring 'value added'

> ... consists of subtracting from the volume aggregates of production (quantities valued at base-year prices) the volume aggregates of materials, fuel and electricity. This procedure eliminates duplication in that double counting arising from the transfer of commodities between establishments in the same industry is cancelled out. [6]

The concept of 'value added' differs from that of G. D. P. originating in that intermediate service inputs are not excluded. This lack of adjustment is not thought to be serious since it is assumed that they are usually proportional to gross value of output. Such an assumption may not be unjustified when we consider that the methods of production in the several firms making up an industry are quite similar for the majority of their products.

Gross Output

In those instances where data limitations preclude the construction of 'net' indicators the best alternative lies in the use of 'gross output'. In the use of such an indicator to represent work done much care must be taken to account for changes in the method of production. For example, if the methods of production in a particular industry are altered to include more processing then the output would be

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6 Dominion Bureau of Statistics, Revised Index of Industrial Production, 1935-1957, p. 23.

understated unless appropriate allowances were made. Quite often this problem can easily be remedied by increasing or decreasing the weight given to that particular industry in the construction of the index.

Materials Used

In those cases were production statistics are not available or prove to be unusable another alternative indicator of the volume of net output which may be used is the volume of materials consumed. As in the case of gross output much care must be taken to account for changes in the methods of production since much alterations will invalidate the proportionality upon which the use of these indicators depends.

Values Adjusted for Price Changes

Again where adequate data are not available for the preperation of any of the aforementioned indicators we may resort to using the value of materials deflated directly by an index of prices or cost of production. This indicator must also be guarded against changes in the methods of production. If appropriate price indexes are unavailable cost of production indexes can be used.

These are arrived at by:

> ... combining unit value indexes of available materials items with average hourly earnings of production workers according to the relative importance of each factor in the base period as determined by total value of materials and total wages. [7]

The indexes so derived are used to deflate the total value of production in each industry. These indexes are not very satisfactory since no allowance is made for changing profit margins or for any costs other than labour and materials. In addition the statistics available are not always representative of the total and therefore very little use is made of these indicators in the preperation of the indexes.

EMPLOYMENT

In a few industries, the only available means of obtaining an approximation of the volume of output is through the use of man-hours worked. The major disadvantage of this technique is that it does not reflect any changes in labour productivity. This deficiency can in some cases be alleviated by applying the productivity increases of similar industries to those where it was not available. Indexes constructed in this manner account for less than two per cent of the overall manufacturing index.

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7 Ibid., p. 24.

In summary, once the volumes of output were arrived at using one of the various techniques described they were employed in the preperation of base-weighted industrial production indexes. The weight applied to each industry and industry sub group, by the Dominion Bureau of Statistics, were determined by their contribution to Gross Domestic Product at factor cost in the base year, (1949). Complete information on the concepts and methods underlying these indexes is available in the Dominion Bureau of Statistics publication Revised Index of Industrial Production, 1935 - 1957, and Indexes of Real Domestic Product by Industry of Origin, 1935 - 1961.

3. Changes in Quality and Product Mix.

In an attempt to isolate quantity and price movements the problem of quality change must be dealt with. Quality changes, which in a production index are expressed as quantity changes, appear in many forms. As one example of quality change consider a series showing the number of automobiles produced. This number series can hide any structural changes which have occured such as a shift from 'compacts' to luxury models. These changes can be reflected in an output measure through the deflation of the value of the output by a currently weighted price index, i.e., by a price index which takes account of the shifts in demand for the various types of a given commodity.

A quality change which is the result of a modification in the component parts of the product cannot be handled as easily. A 1967 television set, for example, has a sharper image, more automatic features and is generally a more efficient instrument than its 1958 counterpart.

> At D. B. S. a measure of quality change is attempted by adopting a convention: a comparison is made of the direct current period quantities of both labour and materials inputs of the new model with that of the old. [8]

If the price of the 1967 television coincides with that of the 1958 television using the convention, then it can be assumed that there has been no change in price but the increase in value is the result of a change in quality.

The major problems associated with changes in quality stems from the fact that sufficient information is not available in many cases and therefore the aforementioned adjustments cannot be made. There are other areas of quality such as changes in servicing contracts, changes in design, and material savings associated with a more compact product, which cannot be quantified on a statistical basis.

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8 Dominion Bureau of Statistics, Indexes of Real Domestic Product by Industry of Origin, 1935-61, p. 41.

> It should be clear from the above ... that quality change is one of the most difficult practical and conceptual problems encountered in quantity and price measurements. Certainly any solution to this general problem can only be arbitrary and based on some convention. [9]

4. Analysis of Growth of Output.

The period covered by the present study was generally one of sustained industrial expansion. Indicative of this sustained increase, the volume of industrial production grew by 121 per cent in the last two decades.

The end of World War II made it necessary for Canadian industry to reconvert their productive facilities to peace-time production. This change was accompanied by a decline in output which did not extend beyond 1946. Following this, output increased in order to satisfy the pent-up demands of both consumers for personal goods and producers for capital equipment. The outbreak of hostilities in Korea in 1950 only served to strengthen the demand for consumer and durable goods.

In 1953, the signing of the armistice saw defence expenditures decline with a consequent decrease in manufacturing acitivities.

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9 Ibid., p. 44.

> At this point stimuli usually associated with longer term demand influences, such as resource investment, housing requirements and an expanding population became more evident, resulting in a rapid recovery; Manufacturing output expanded by 18 per cent between 1954 and 1956. [10]

During the period 1957-60, the growth of output in the manufacturing sector was moderate, with some years showing actual declines. With the advent of the 1961 expansionary phase, the manufacturing sector recorded substantial gains in its output performance. In 1962, manufacturing production rose by nearly 10 per cent over 1961. To date, the upward trend begun in 1961 has continued virtually without interruption.

As illustrated by Chart I, all industry groups did not share equally in this advance in manufacturing output. Among those showing the largest gains were the petroleum and coal products industry (237 per cent), the non-metallic products industry (206 per cent), the electrical apparatus and supplies industry (166 per cent), and the chemical products industry (152 per cent). These industries were closely associated the rapidly growing resource-development and capital investment programmes that characterized this period.

Those industries which exibited only moderate growth (50 per cent to 100 per cent), ranked in order of size of increase, are as follows:

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10 Ibid., p. 23.

miscellaneous manufacturing industries, tobacco products industries, the printing and publishing industry, the paper products industry, the non-ferrous metal products industry, the iron and steel products industry, the transportation equipment industry, the rubber products industry, and the wood products industry. Those showing the smallest gains were the foods and beverages industry, the textiles industry, the clothing industry, and the leather products industry. This latter industry showed little or no gain over the period.

The post-war period was characterized by four major expansions. The first was based on satisfying the needs of the war-devastated countries. The second was based on the demand created by the outbreak of the Korean War and on stock-piling requirements at home and abroad. The third was the investment boom of the mid-fifties which was based on raw materials exploration and development. The last surge in demand and production was that which had its beginning in the latter part of 1961 and which has extended itself to the present. This latter expansion has yet to show any signs of abatement.

These strong demand influences combined to make most of the period one of fairly rapid and sustained growth. Along with the increases in total final demand there were also shifts in the composition of demand, as evidenced by Table II, which affected the output of various industries. Imports, over the

TABLE II

PERCENTAGE DISTRIBUTION OF GROSS NATIONAL EXPENDITURE
(Selected Years)

	1946	1949	1953	1956	1959	1961	1964
Personal Expenditure	67.8	66.8	62.4	61.6	64.7	65.8	62.6
Durables	5.0	7.0	8.0	8.0	7.7	7.3	7.6
Non-durables	40.8	38.5	32.8	31.8	32.5	32.9	30.5
Services	22.0	21.3	21.6	21.8	24.5	25.6	24.5
Government Expenditure	15.2	13.0	17.7	17.6	18.6	19.5	18.3
Business Gross Fixed Capital Formation	11.7	18.6	20.0	22.2	19.8	17.6	19.1
New residential construction	3.1	4.9	4.7	5.0	5.0	3.9	4.3
New non-residential construction	3.7	5.6	6.9	8.5	7.4	7.2	7.1
New machinery and equipment	4.9	8.1	8.4	8.7	7.4	6.5	7.7
Exports	27.1	24.6	21.6	20.8	19.2	20.6	22.2
Imports	-24.6	-23.6	-23.5	-25.2	-23.4	-23.0	-23.1

Source: National Accounts, Income and Expenditure, 1926-1956 and 1964.

period, retained roughly the same share of G. N. P., while exports, as a percentage of expenditure of G. N. P., declined from 27. 1 per cent in 1946 to 20. 6 per cent in 1961.

> This would appear to be an indication of the growing importance of domestic market as an outlet for the products of Canadian industry. [11]

Although the importance of personal expenditure declined slightly over the period, it is of interest to note that consumer expenditures have shifted their emphasis from non-durables to durable goods and services. The increased importance of the durable goods and services expenditure categories may be the result of the increased affluence of the population and of a shift from rural towards suburban living. This latter factor can be very influential in the demand for such consumer durables as automobiles, furniture and appliances which have claimed a large share of the increased output over the period.

Strong gains were also made in the area of government expenditure and business gross fixed capital formation. The gains experienced in this latter category were accounted for, in large part, by the increased expenditures on new-non-residential construction and new machinery and equipment.

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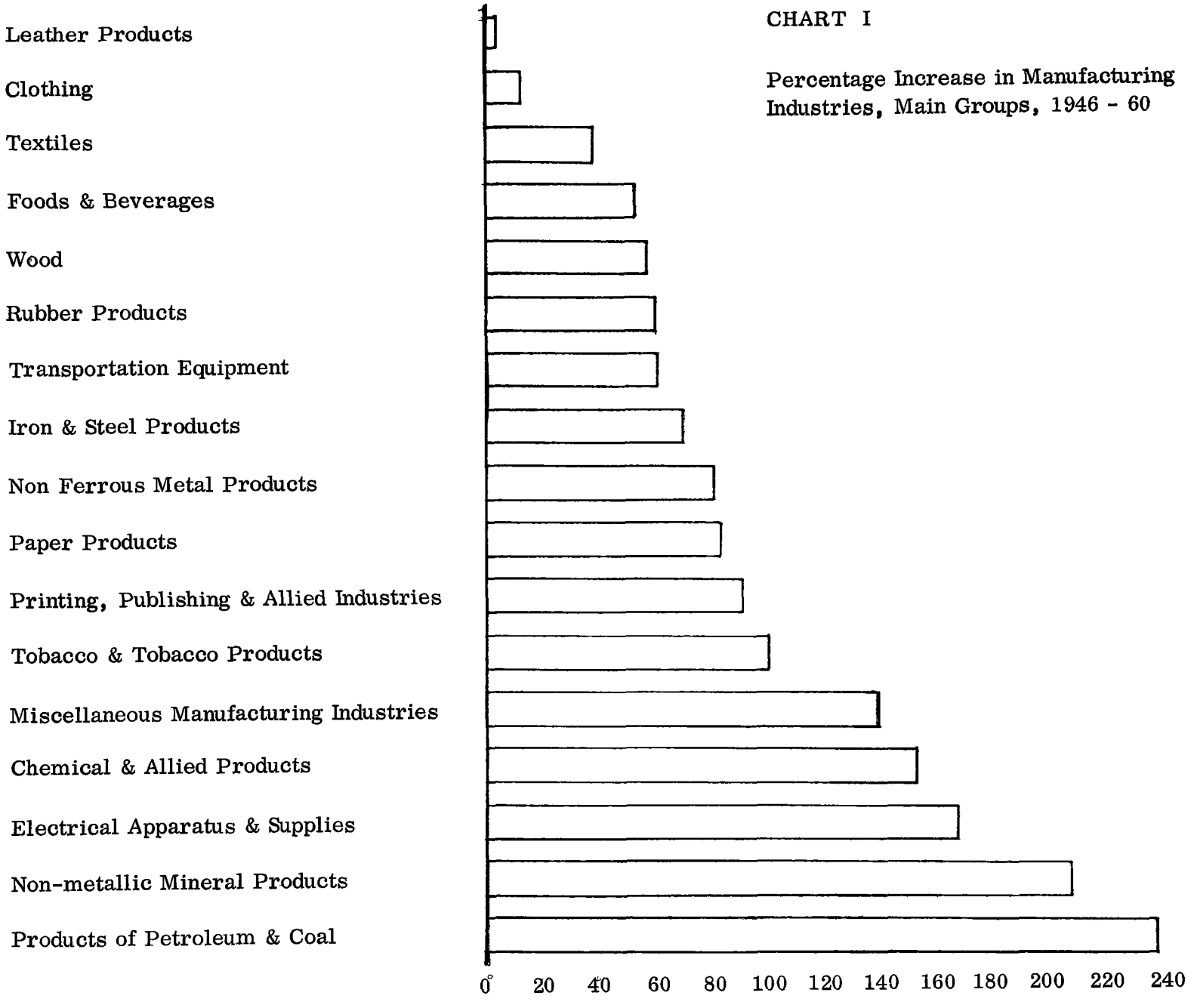
11 Ibid., p. 20.

CHART I

Percentage Increase in Manufacturing Industries, Main Groups, 1946 - 60



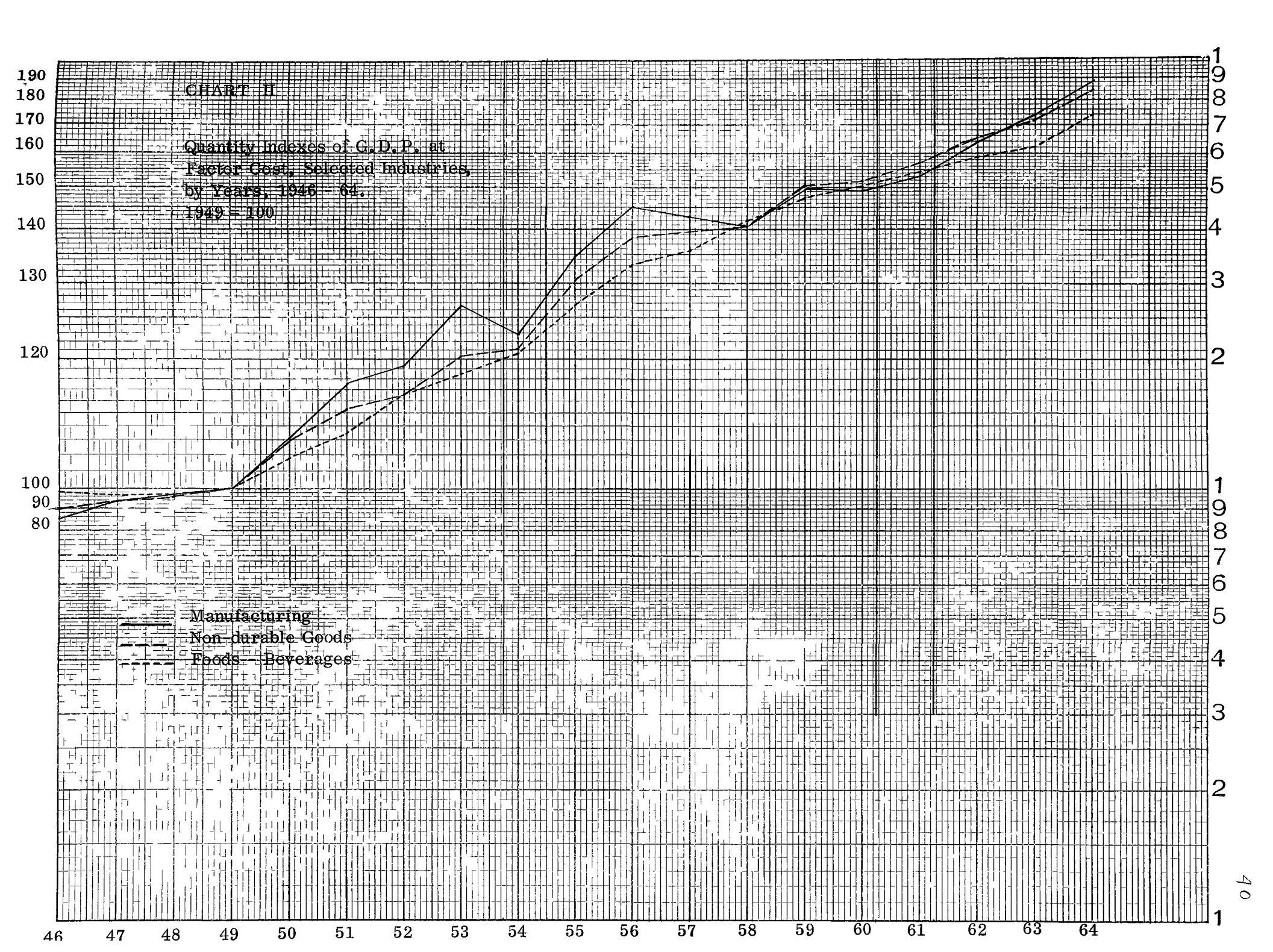


CHART II
Quantity Indexes of G.D.P. at Factor Cost, Selected Industries, by Years, 1946 - 64.
1949 = 100
190
180
170
160
150
140
130
120
100
90
80
Manufacturing
Non-durable Goods
Foods - Beverages
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64

Economic Fluctuations, 1946-1964

As mentioned earlier, the post-war period has been marked by three major production cycles.

> The downward phases of these cycles extended from the third quarter of 1953 to the second quarter of 1954 for the first cycle; from the fourth quarter of 1956 to the fourth quarter of 1957 for the second cycle; and from the first quarter of 1960 to the first quarter of 1961 for the third cycle. The expansionary phase of the first cycle extended from the third quarter of 1954 to the fourth quarter of 1956, while that of the second cycle lasted from the first quarter of 1958 to the first quarter of 1960. [12]

In the third cycle, production began to expand during the second quarter of 1961 and has extended itself to the present virtually without interruption.

Within the manufacturing sector, the trade cycles previously described have had varying effects on the constituent industries. These effects range from pronounced cyclical patterns through irregular behavior to relatively smooth and sustained expansion. Those industries with pronounced cyclical patterns would exert considerable influence on the amplitude, timing and duration of the cycle while those whose behavior was erratic would either accentuate or dampen the cycle. Those industries which exibited little cyclical activity could be expected to exert a stabilizing influence.

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12 Ibid., p. 27.

For analytical purposes it is essential that the manufacturing sector be broken down into the non-durable goods industries and the durable goods industries. It is evident from Chart II that the non-durable goods industries have exerted a stabilizing influence on the behaviour of the trade cycle. The relative cyclical insensitivity of non-durables can, for the most part, be traced to the predominance of such steadily expanding components as foods and beverages. This behaviour pattern can be traced to the relative cyclical stability of non-durables in the personal expenditure category of G.N.E. This phenomenon can be taken as evidence of the fact that most consumers have proven themselves to be initially reluctant to accept any reduction in their basic standards of consumption in recessionary periods. The technique of drawing on savings to sustain a certain standard of consumption is limited by the availability of such savings and the duration of the recessionary phase.

The durable manufacturing industries group has, on the other hand, exibited a strong cyclical pattern. Clearly, it is the durable manufacturing component that accounted for the pronounced cyclical pattern in total manufacturing. These patterns are illustrated in Chart III where it can be seen that the downturns in a few representative industries and in the aggregate measure of durable manufacturing correspond exactly to the recession phases of the economy, and thus tend to amplify the cycle. These trends may be traced to the cyclical sensitivity of personal expenditure on durable goods and of business expenditure on new machinery and equipment in G.N.E. It is also of interest

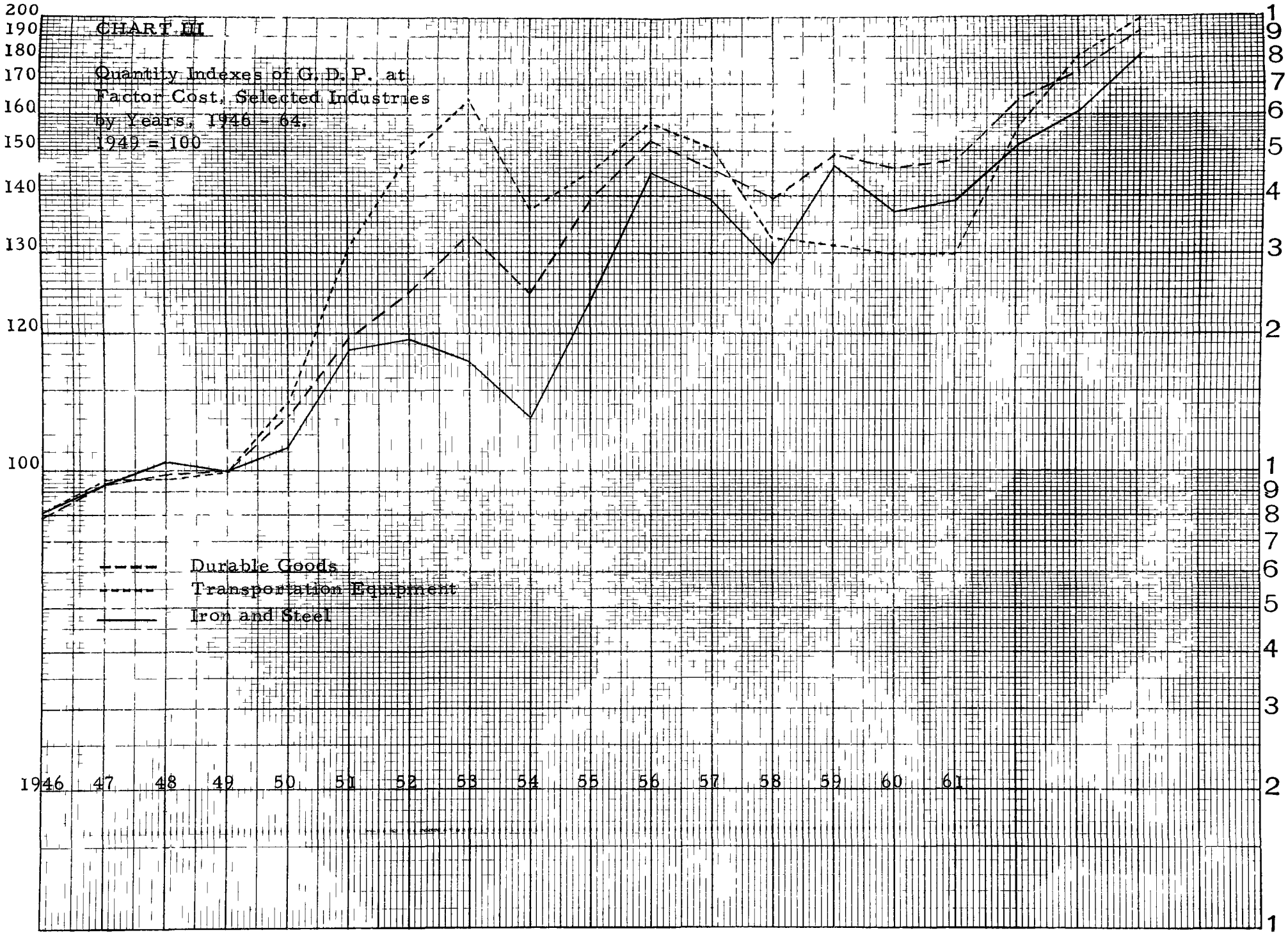
CHART III
Quantity Indexes of G. D. P. at Factor Cost, Selected Industries by Years, 1946 - 64.
1949 = 100
200
190
180
170
160
150
140
130
120
100
Durable Goods
Transportation Equipment
Iron and Steel
1946
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61

to notice the relationship which exists between the producer and his suppliers. An example of this is apparent in Chart III. The similarity of output fluctuations between the transportation equipment industry and the steel industry indicates both their interdependence and their sensitivity to general business fluctuations.

CHAPTER III

LABOUR INPUT

This chapter sets out the concepts, sources and techniques used in measuring labour input. This is followed by an analysis of the contributions which the various components of labour input make to create a given total output.

1. Concepts, Sources and Measures.

The basic concept of labour input utilized in this thesis is that of labour time. This concept can be expressed in terms of hours worked or hours paid. Hours worked refers only to the actual time the workers spend in activities which contribute directly to the creation of the output. On the other hand, the hours paid concept includes all the time for which the worker receives renumeration, including holidays, vacations, sick leave, etc.

From the standpoint of defining a purely physical relationship between output and input, man-hours worked would seem to be the most appropriate concept since it relates the physical output to a measure of the man-hours expended in its creation. Unfortunatly, the data required to present estimates based on this concept are not available for much of the period under consideration.

However, a case can be made for the use of the hours paid concept if we adopt the view that the employer, if he is to obtain the services of labour, must grant certain fringe benefits such as holidays, vacations, sick leave, etc.

If this position is adopted then costs which arise from the granting of fringe benefits can be considered as a legitimate part of aggregate labour input.

Until comparatively recently, it seemed that the average annual employment and man-hours of production workers only could be taken as representative of the trend over a period of years in the labour input of most industries, since office staff and other non-production workers were comparatively few in number and their relative importance changed only slightly. More recently, however, the proportion of non-production workers in the labour force has increased quite markedly. This change has generally been associated with the quickening pace of technological change and the growing importance of the marketing function, both of which have required the creation of large support staffs not directly engaged in production. In the light of the growing importance of this segment of the labour force it would seem advisable to include non-production workers in the estimates of labour input.

> In productivity measures which relate output to labour input, the labour component should refer to all persons employed. Since the entire composite of an establishment's labour force contributes to the final output, whether in production or management, engineering and other "nonproduction" activity, for general economic analysis it is conceptually desirable to relate output to all persons employed. [1]

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1 Canada, Dominion Bureau of Statistics, Indexes of Output Per Persons Employed and Per Man-Hour in Canada, Commercial Non Agricultural Industries, 1947-63, (Ottawa, Queen's Printer, 1965), p. 38.

For purposes of comparability, information on employment, wages, salaries, and hours was taken from the following Dominion Bureau of Statistics publications: General Review of the Manufacturing Industries of Canada, and Earnings and Hours of Work in Manufacturing. These publications were preferable since they are also the sources from which the respective output indexes are constructed. This information is usually presented by sex, industry, geographic area, and by class of worker, i.e., salaried and production workers. The General Review of Manufacturing defines salaried workers to include:

> All executives and supervisory officials such as presidents, vice presidents, secretaries, treasurers, together with managers, professional and technical employees, superintendents and factory supervisors above the working foremen level and clerical employers. Working owners and partners are also included in this category. [2]

Production workers include all other factory workmen whether paid on a monthly, weekly, hourly or piecework basis. Working foremen, doing work similar to that of the employees they supervise are included as are maintenance, warehousing and delivery staffs. Employees on new construction work and in retail or wholesale operations are excluded since they are covered in the construction industry or in the relevant service industry.

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2 Canada, Dominion Bureau of Statistics, General Review of the Manufacturing Industries of Canada, 1959, (Ottawa, Queen's Printer, 1962), p. 11.

The exclusion of employees engaged in new construction work should not affect the productivity estimates since the output attributable to their efforts is also excluded.

Statistics on employment of salaried workers contained in the aforementioned publications refer to a reported average for the year whereas those reported for production workers refer to an average of paid workers reported in each month of the year.

Statistics on hourly earnings as well as hours worked per week are obtained from an annual survey in the last week of October covering the larger manufacturing establishments. Based on this survey and supporting monthly samples, weighted averages are computed for hourly and weekly earnings and for hours worked during the week. The annual and monthly surveys, from which information on earnings and hours are computed, cover establishments usually employing 15 or more persons and include almost 90 per cent of all employees reported to the Annual Census of Manufacturers.

The above information suggests the possibility of two alternative methods of estimating, for each industry, total man-hours paid per year. The first of these is the 'pay deflation' method which consists of dividing total earnings paid out as reported to the Census of Manufacturers by the average hourly rate prevailing in that industry. Seperate calculations must be made for salaried and production workers because there usually exists a considerable

difference in the hourly rates of these two categories of workers.

Although both methods yield estimates of paid man-hours per year, the 'pay deflation' method is considered to be more satisfactory than the 'employment inflation' method because the former technique is based on accounting records of payroll as reported in the Census of Manufactures while the latter method is based on sample data. Since the accounting data represent information obtained from each firm in the industry while the sample data cover only a representative number of firms, it would seem, a priori, that the former should be more accurate than the latter. The 'pay deflation' method was adopted and used consistently throughout the period under review.

Statistics on salaries and wages are available at the industry level from the Census of Manufacturers for the period 1949 - 1959. Prior to 1949, information relating to payrolls was collected without any distinction being made as between salaries and wages. For purposes of comparability it was therefore necessary to transform the data in such a way as to permit seperate calculations of salaried and production man-hours. The procedure followed was to take the average proportion of salaries to wages in the years from 1949 to 1951 and to apply the result to the 1946-48 data, thus yielding seperate estimates of payrolls for salaried and production workers which could then be used to compute paid man-hour estimates for each group by industry. This method was employed because it was found that little variability existed in the

proportion of salaries to wages in the years from 1949 to 1951 and therefore it was assumed that the same behaviour could be expected in the 1946-48 period.

In 1959, the Standard Industrial Classification, on the basis of which Census of Manufacturers data are compiled, was changed. This alteration necessitated that all the subsequently published data be converted to a 1948 S.I.C. basis so as to ensure, in as much as it was possible, the comparability of the series.

> The changes in classification..., the addition of new industries and the transfer of industries from manufacturing to other sectors of the economy, make it extremely difficult to compare the manufacturing statistics compiled on the revised classification basis with those compiled on the old basis. [3]

In 1962, the definition of salaried workers was expanded to include:

> ...employees engaged in activities such as advertising, credit collections, purchasing, personnel, legal, medical, etc. [4]

In addition the salaries of sales and distribution personnel were included in the new definition.

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3 Ibid., 1960, p. 15.

4 Canada, Dominion Bureau of Statistics, Manufacturing Industries of Canada, 1962, (Ottawa, Queen's Printer, 1965), p. 43.

In order to obtain a comparable estimate of salaries for the period following this change it was necessary to deflate the published data. By comparing the 1961 salary statistics, for each industry, before and after the change in concepts, it was possible to arrive at an adjustment factor which could be applied to the data of subsequent years.

Once values for paid man-hours were obtained for salaried and production workers they were transformed into index number using 1949 as a base year to be consistent with the indexes of output. The indexes of salaried and production man-hours were combined in such a way as to reflect the proportion of value added attributable to each category in each year.

2. Employment, Hours and Renumeration of Labour.

For the comparisons that follow, the relevant data are drawn mostly from the Dominion Bureau of Statistics publications, Earnings and Hours of Work in Manufacturing, and the General Review of the Manufacturing Industries of Canada. The behaviour of salaried employees and production workers will be analysed seperatly.

Employment

On the basis of the information presented in Table III it can be seen that only a few industries showed substantial increases in the employment of production workers during the period. In fact, four industries recorded actual

declines in the number of production workers employed. However, quite the reverse is true for salaried employees, where most industries reported substantial gains. This trend towards an increased proportion of salaried employees is evidence of the growing importance of the marketing and managerial functions in modern industry.

The proportion of the total labour force employed in the manufacturing sector has remained relatively stable over the period under consideration, though there have been some substantial inter-industry shifts in the distribution of employment. In the case of production workers, employment in the Tobacco, Rubber, Leather and Textile industries has declined while the Non-metallic Minerals, Miscellaneous Manufacturing, Printing, Paper and Electrical Apparatus industries have shown substantial increases in the numbers of workers employed over the same period. In the case of salaried employees much the same behaviour is observable except that all industries recorded gains in the employment of this type of worker over the period.

The differences in rates of increases of employment in both these categories of workers may be taken as evidence of the differing demand conditions prevailing in the various industries. These trends in employment may also be attributable, to some degree, to the changes in mechanization which took place in the various industries over the period under consideration.

The industries which exhibited substantial growth in the employment of salaried and production workers correspond generally to the group of industries which experienced the largest growth of output over the same period. The Tobacco Products and Petroleum and Coal industries did not conform to this pattern, for although they recorded substantial gains in output, their employment of production workers, over the period, remained relatively stable. In both cases, the increased output capacity is probably rooted in the high degree of mechanization or capital intensity which characterizes these industries.

Other inter-industry shifts in employment occured during the period in question. These relate to the growing importance of the salaried employee category in each industry. This trend is observable in each of the industries surveyed.

Hours

During the period 1948 to 1964, there was a widespread tendency for the length of the working week of salaried and production workers to decline. In the case of production workers the percentage decline varied from 2.1 per cent in the Miscellaneous Manufacturing industry to 11.0 per cent in the Paper Products industry. The decline in the length of the average work week for salaried workers was more pronounced and varied from 1.2 per cent in the Electrical Apparatus industry to 8.7 per cent in the Non-ferrous Metals industry. The shortening of the work week modified the movements of total man-hours

TABLE III

SELECTED STATISTICS FOR THE MANUFACTURING INDUSTRIES
EMPLOYMENT AND OUTPUT
1948-1960

INDUSTRY		Change in employment of production workers %	Change in employment of salaried employees %	Proportion of salaried workers to total employment 1948	Proportion of salaried workers to total employment 1960	Change in output %
Foods, Beverages		39	92	16	21	53
Tobacco	*	17	7	15	19	89
Rubber	*	16	27	19	27	23
Leather	*	6	16	11	14	17
Textiles	*	25	48	11	20	26
Clothing		5	18	12	13	11
Paper		25	84	14	20	56
Printing		34	71	34	40	58
Petrol and Coal		11	132	23	44	179
Chemicals		19	72	35	45	130
Miscellaneous		73	204	17	27	135
Wood		10	73	10	15	35
Iron and Steel		1	67	17	27	35
Transportation		1	93	14	25	28
Non Ferrous Metals		7	53	18	24	49
Electrical		20	102	25	37	97
Non Metallic Minerals		44	137	15	23	129

* Decline

paid which nonetheless generally paralleled the behaviour of the employment data for both categories of workers.

Remuneration of Labour

The renumeration of labour in the manufacturing sector may be considered from two points of view: as a cost to industry and as earnings of its employers. As with regard to the former, what is the relative importance of labour costs in the industry and to what extent have these varied over the period surveyed? To the extent that salaries and wages paid can be taken as an approximation of total factor income, the ratio of these two magnitudes is a useful indication of the importance of labour costs. By implication such ratios are highly suggestive of the capital intensity of the industries concerned.

From Table IV it can be seen that major changes in the proportion of salaries and wages paid to value added by manufacturing occured only in those industries which recorded declines in the importance of labour costs. Except for the Tobacco industry all declines in the importance of labour costs occured in industries which manufacture durable goods. On the other hand, the industries which exhibited relative stability in this area were largely industries engaged in the manufacture of non-durable goods.

Table IV also gives estimates of the relative importance of labour costs in each industry, which, as mentioned earlier, are suggestive of the capital intensity which characterises each industry. This implied relationship

TABLE IV

SALARIES AND WAGES PAID AS A PERCENTAGE
OF VALUE ADDED
THE MANUFACTURING INDUSTRY
1946-1960

INDUSTRY	1946 %	1960 %	Change
Chemicals	33	35	2
Non-metallic Minerals, and Products of Petrdleum and Coal	34	40	6
Foods and Beverages	40	41	1
Paper Products	40	44	4
Non-ferrous Metals, and Electrical Apparatus and Supplies	54	47	- 7
Tobacco, Rubber, and Leather Products	47	48	1
Miscellaneous Manufacturing	52	53	1
Iron and Steel Products	61	55	- 6
Textile Products	54	56	2
Printing, Publishing and Allied Industries	56	56	-
Transportation Equipment	72	58	-14
Wood Products	56	60	4
Clothing	56	61	5

is, with some exceptions, borne out in fact as can readily be seen from Table V.

The manufacturing sector, during the period 1948 to 1964, has been characterized by steadily increasing wages and salaries. In general, the earnings of salaried employees were higher and rose faster than did those of the production workers. The disparity between the wages of salaried and production workers may, in part, be explained by the inclusion of the earnings of owners, managers and other highly paid executives in the salary estimates, which would have the tendency to raise the overall average for the category. The industries which showed the largest increases in salaries and wages were once again largely those which had a record of high growth of output.

Of the three variables with which the labour input is associated, only one factor, employment, seems to be affected significantly by the vagaries of the business cycle. Average hours per week declined steadily over the period and salary and wage rates increased steadily. The constancy of wage and salary rates and the sensitivity of employment to business cycles is illustrated in Chart III. The behaviour of these two variables gives evidence to the belief that workers and trade unions would rather suffer a degree of unemployment than see wage rates decline.

Although it may be topical at this point to discuss the relation between salaries and wages and productivity, such discussion has been deferred to the last chapter where the estimates of productivity are presented and analysed.

TABLE V

GROSS FIXED CAPITAL STOCK PER PERSON
EMPLOYED IN MANUFACTURING
1960
(Constant 1949 Dollars)

INDUSTRY	Employment	Fixed Capital (000,000)	Capital Intensity $
Non-metallic Minerals, and Products of Petroleum and Coal	51,682	1,728	33,435
Paper Products	93,748	2,246	23,958
Chemicals	54,414	1,302	23,928
Non-ferrous Metals, and Electrical Apparatus and Supplies	127,595	1,706	13,370
Textiles	58,253	635	10,901
Iron and Steel Products	168,396	1,720	10,214
Foods and Beverages	173,924	1,776	10,211
Transportation Equipment	112,076	878	7,834
Wood Products	88,897	684	7,694
Printing, Publishing and Allied Industries	60,037	450	7,495
Tobacco, Rubber, and Leather Products	56,473	353	6,251
Miscellaneous Manufacturing	33,265	140	4,208
Clothing	97,405	234	2,402

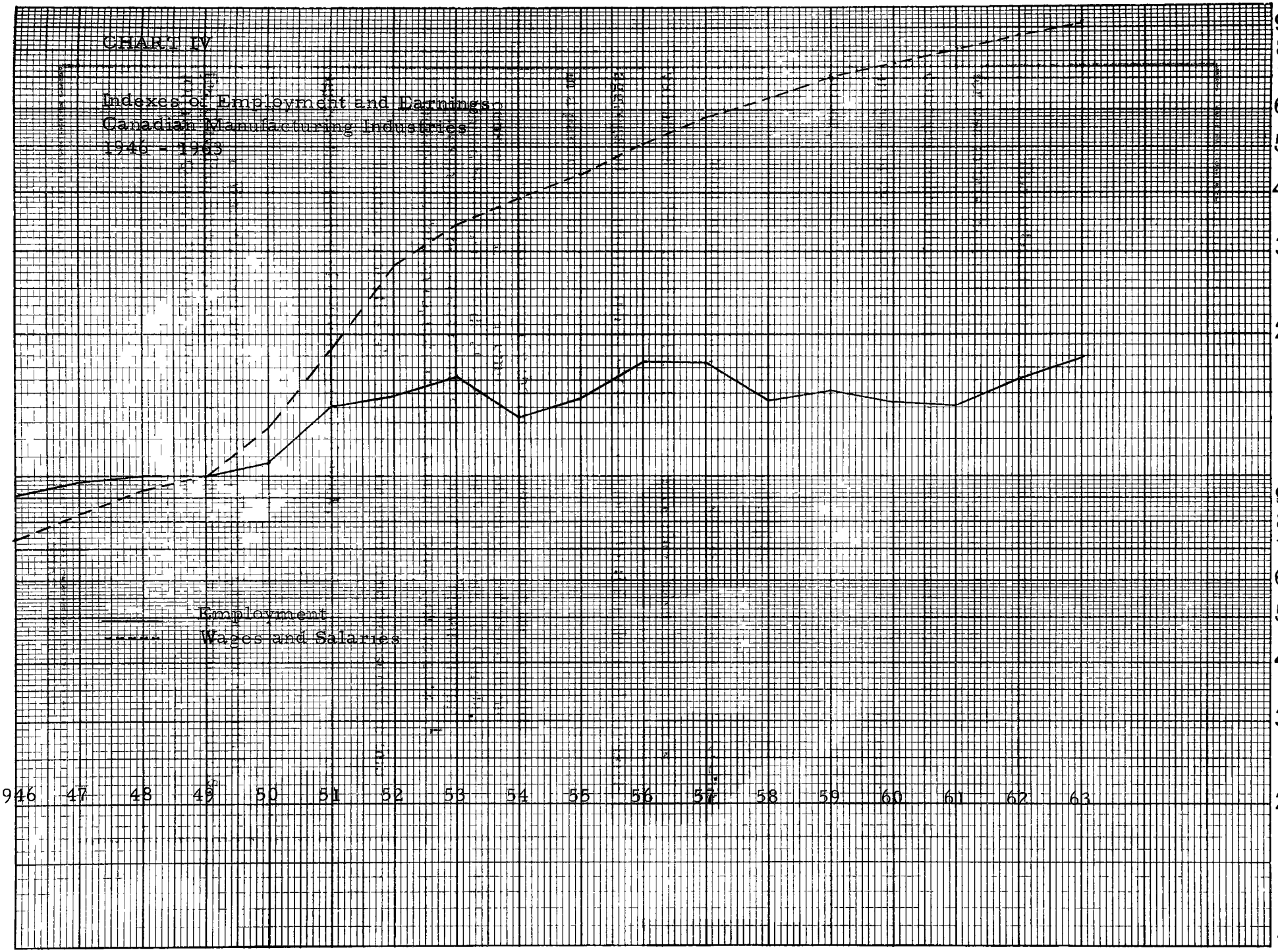
CHART IV
Indexes of Employment and Earnings
Canadian Manufacturing Industries
1946 - 1963
Employment
Wages and Salaries
1946
47
48
49
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1

CHAPTER IV

CAPITAL INPUT

This technique of estimating reproducible fixed capital stock adopted for use in this thesis is that known as the "perpetual inventory" method. The concepts underlying this and other techniques are presented followed by an analysis of the growth of reproducible fixed capital stock in the manufacturing sector.

1. Alternative Techniques.

Most corporations and many other businesses carry in their accounts valuations of their fixed assets. These balance sheet asset figures can be aggregated by industry and by sector to provide a total for the whole economy in a particular year.

> This is approximately the method used to obtain the so-called census of capital, capital employed, or of wealth, published in the United States and Canada at various times in the past. In Canada, for example, the census of industry collected from manufacturing enterprises data on capital employed annually from 1920 to 1943. [1]

Taxation statistics also present data which lend themselves to this aggregative method of estimating capital stock.

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1 Wm. C. Hood and Anthony Scott, Output, Labour and Capital in the Canadian Economy, Royal Commission on Canada's Economic Prospects, (Ottawa, Queen's Printer, 1957) pp. 231-32.

> It is generally believed that such information is not reliable, or that if it is reliable, it is very hard to interpret. Corporations responding to questionaires use different methods of valuing their capital: they may, for example, use original cost, market price or replacement cost; they may show figures net or gross of depreciation; they may include or exclude land; they may unexpectedly write up or down the value of fixed assets to include the goodwill of the enterprise on the occasion of a financial reorganization. [2]

They are valid reasons for the use of these various valuation procedures, and if all enterprises followed the same methods or if it were known how many firms followed each method, some use could be made of the aggregate data. The difficulty arises from the fact that the number of firms using each method is unknown. Further, as corporations change ownership, financial structure or tax situation they may wish to change the accounting convention followed in the valuation of their assets. All these factors tend to limit the usefulness of these estimates for the purposes of economic analysis.

We may now review a technique known as the capitalization method which has been used from time to time by individual scholars, especially in the United Kingdom.

> The basic procedure depends upon first estimating the income arising from various kinds of assets. These incomes must then be capitalized at various conventional ratios of capital value to income, which are usually called the relevant number of "years' purchase". [3]

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2 Ibid., p. 232.

3 Ibid., p. 233.

The term "years' purchase" refers to the time required for the profits of a particular asset to add up to the purchase price of that asset. Once the incomes of the assets have been capitalized they can be aggregated to yield estimates of capital stock.

This method however requires a precise classification of the various types and sources of income such as is perhaps only available under the British schedular income tax system. In Canada, income tax returns are not on the whole classified by the kind of property which gives rise to the income. Moreover, many incomes are made up of unassorted mixtures of wages, profits, rents and interests. These facts would tend to make the use of capitalization method in Canada quite difficult.

2. Perpetual Inventory Method.

This method was fully developed by Raymond Goldsmith in the U.S.A., (4) used by Redfern in the U.K. (5) and adopted by Hood and Scott in Canada (6) and by the D.B.S. in its capital stock project (7)

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4 R.W. Goldsmith, "Measuring National Wealth in a System of Social Accounting", Studies in Income and Wealth, National Bureau of Economic Research, Vol. XII, (New York, NBER, 1950).

5 D. Redfern, "Net Investment in Fixed Assets in the United Kingdom, 1938-1942", Journal of the Royal Statistical Society CXVIII, (Series A) 1955 No. 2, pp. 141-192.

6 Wm. C. Hood and A. Scott, op.cit.

7 D.B.S., Preliminary Estimates of Fixed Capital Flows and Stocks, Canada 1946-1960, Ottawa, D.B.S. Daily Bulletin Supplement 2, Tuesday, December 22, 1964, p. 11.

The "perpetual inventory" method of measuring the stock of fixed capital requires three basic building blocks; (I) historical time series of current dollar gross fixed capital formation for similar types of capital goods purchased by the industries for which stock measurement is being attempted; (II) price indexes pertaining to the types of capital goods for which current dollar gross fixed formation data exist; and (III) data on the "average economic life" or service life of capital goods.

The mechanics of the "perpetual inventory" method of measuring the stock of fixed reproducible capital by industry are relatively straightforward. Generally speaking, the technique involves the addition over a period of years of purchases of capital goods by an industry to derive its capital stock in any particular year. More specifically, if we assume that a particular industry uses machinery and equipment which will remain in productive service, until scrapped or discarded, for (say) an average of twenty years, this twenty years corresponds to the service life of the asset. If purchases of such capital goods, i.e. gross fixed capital formation, adjusted for price changes are aggregated for a period of twenty years, then in the twentieth year, a measure of the stock of this industry's machinery and equipment is derived. In the twenty-first year, the machinery and equipment purchased in the first year is, assumed to be withdrawn from the stock qhile that purchased in the twenty-first year is added. This procedure is repeated for all subsequent years, hence the name "perpetual inventory" method.

If depreciation rates are applied against the resulting gross stock estimates, then annual valued of consumption allowances can also be derived. When the yearly capital consumption allowances are subtracted from the gross fixed capital formation data, then the increase in the stock of machinery and equipment, adjusted for wear and tear and absolescence undergone by the existing capital goods, i.e. net fixed capital formation, is also measured. Aggregation of net fixed capital formation data yields estimates of the net stock of fixed capital. Net stock of capital is equal, in each year, to gross stock of capital less accumulated capital consumption allowances over the past twenty years or over a period corresponding to the service life of the assets of a particular industry.

A more complete understanding of the technique of measurement of the stock of fixed reproducible capital by industry may be gained if a more detailed exposition of the method is outlined. Assume that we are concerned with the machinery and equipment stock of a particular industry. The procedure is then as follows:

(A) Obtain, or if necessary, estimate a time series of current dollar gross fixed capital formation for machinery and equipment of the industry. How far back in time the series must be pushed is a function of the assumed service life and the year for which it is desirable to open with stock estimates. If, for example, the assumed service life is 20 years and the opening year of the estimates is 1949, then the series must be pushed back to 1929.

(B) Obtain, or again if necessary, construct a price index of capital goods whose commodity coverage is similar to that of the machinery and equipment gross fixed capital formation series of the industry under consideration. Ideally, the index should be one that reflects the changing composition of the series, i.e. a currently weighted Paasche index. However, this is often difficult to obtain due to the wealth of commodity detail required for its construction.

(C) The current dollar gross fixed capital formation series is then deflated. That is, the current dollar gross fixed capital formation data are divided through by the price index to derive capital formation estimates expressed in terms of the average price of capital goods in the year which is the time reference base of the price index. This deflation procedure is necessary to ensure that the time series will not be biassed by price fluctuations. This will then yield estimates of constant dollar gross fixed capital formation.

(D) On the basis of available data, it is assumed that the machinery and equipment used by this industry have an "average economic life" or service life of twenty years. It is assumed that the capital goods, to which this estimate of service life applies, installed by the industry in year one remain in the stock until the twenty-first year at which time they are withdrawn from the stock. Therefore, if the constant dollar gross fixed capital formation data are aggregated for twenty years, then at the end of the twentieth year, a measure of the gross stock of machinery and equipment for that industry is derived.

For subsequent years, the new additions in each year are added to the stock while the additions made twenty years ago are deducted.

(E) The assumed service life of the machinery and equipment implies that by the time it is discarded or scrapped the machinery and equipment installed twenty years ago has negligible market value. Some method must be found to write off this decline in the value of machinery and equipment over its life. The estimates compiled by D.B.S. and which are used in this thesis were prepared using the "straight line" method of calculating depreciation. Thus, if the assumed service life is twenty years, then one twentieth of the gross stock will provide an estimate of the constant dollar value by which the stock declines in value each year. The application of the depreciation function thus yields annual estimates of constant dollar capital consumption allowances.

(F) If we subtract these capital consumption allowances from the estimates of constant dollar gross fixed capital formation every year, we obtain a measure of the addition to the stock of machinery and equipment in constant dollars where allowances have been made for the effects of wear and tear, ageing and obsolescence on the value of existing stock. These estimates are called net fixed capital formation in constant dollars. If these estimates are aggregated we obtain for each year a measure of net fixed capital stock of machinery and equipment.

However, it should be noted that gross rather than net fixed capital stock estimates are used in the computation of the productivity estimates presented in this thesis because the denominator of the productivity ratio, i.e. real output, contains no adjustment for capital cost allowances. The use of net fixed capital stock in the denominator of the ratio would tend to create an upward bias in the productivity estimates.

3. Sources.

As explained in Section II, the use of the perpetual inventory method for estimating gross and net stock of reproducible capital requires three sets of data:

a) current dollar estimates of gross fixed capital formation;

b) price indexes relating to gross fixed capital formation and

c) estimates of the average economic lives of the commodities making up the stock.

(a) Estimates of Gross Fixed Capital Formation

For the period 1926-1945, the estimates of current dollar gross fixed capital formation by Major groups in manufacturing are taken from Department of Trade and Commerce, Private and Public Investment in Canada 1926-1951, Tables 26-39. These estimates were derived from a sample of corporate income tax returns to the Department of National Revenue for 358 companies engaged in manufacturing in 1946 and active during the preceding twenty year period.

The estimates from 1946 on are derived from the Department of Trade and Commerce's Capital Expenditure Survey, a joint undertaking by the Economics Branch of the Department of Trade and Commerce and the Business Finance Division of the D.B.S. Historical data for the period 1946-1957 are contained in D.B.S. 61-504, Private and Public Investment in Canada 1946-1957.

For the years 1958 to 1964, the data are obtained from the Department of Trade and Commerce, Private and Public Investment in Canada Outlooks 1960, 1961, 1962, 1963, 1964, 1965 and 1966.

The data for the period 1926 to 1945 on capital expenditures from PPI 1926-1951 are available only for combined Tobacco, Rubber and Leather Products Major Groups, the combined Non-ferrous Metals and Electrical Apparatus and Supplies Major Groups and the combined Non-metallic Minerals and Products of Petroleum and Coal Major Groups. It is not possible to obtain a breakdown of these data into its Major Group components. Thus, the productivity estimates in this report are prepared for thirteen combined Major Groups rather than seventeen individual Major Groups in Manufacturing.

(b) Price Indexes

The price index used for deflating the construction component of current dollar gross fixed capital formation in manufacturing was prepared in the following manner. From the D.B.S. reference paper Price Index of

Non-residential Building Materials 1935-1952, broad materials commodity groups weights, by different types of structures were obtained. The weights given for factories were assumed to be appropriate for the derivation of the building construction deflator for manufacturing industries. The commodity groups and weights are given in Table VI.

Price indexes for these groups of non-residential building materials are provided in the Reverence Paper and in subsequent issues of Prices and Price Indexes, D.B.S. catalogue No. 62-002.

With respect to the labour component, the index of average hourly earnings in building construction activity in the Construction Industry obtained from various issues of D.B.S. Review of Man-Hours and Hourly Earnings, 72-202 for the years 1945 to 1964 and the index of wage rates in the Construction Industry from the Department of Labour, Wage Rates, Salaries and Hours of Labour 1964 and earlier issues of the same report were averaged simply together.

The labour and materials index for building construction were combined using the following weights: building materials, 0.606, labour 0.394. These weights were arrived at by the D.B.S. on the basis of data obtained from working papers underlying the reference paper Price Index of Non-residential Building Materials 1935-1952.

The price indexes used to deflate machinery and equipment current dollar gross fixed capital formation from 1955 to 1964 were obtained from the D.B.S. Prices Division. These indexes, as yet unpublished, relate to the prices of machinery and equipment, both domestically - produced and imported, purchased on capital account by selected Canadian industries and municipal governments. In general, these indexes resemble the industry selling price indexes currently being produced by D.B.S. However, detailed elaboration of the nature and limitations of these price indexes must await their publication by the Prices Division.

These indexes are computed for nine Major Groups and for total manufacturing. The technique followed in the unpublished D.B.S. capital stock study and in this thesis was to apply these nine indexes to the data of those industries to which they were specifically related, and to deflate the data of the remaining industries using the index of total manufacturing. These indexes use 1955 as the base year. They have been converted to a 1949 base for purposes of comparability.

(c) Service Life

The weakest link in the set of capital stock estimates presented in this thesis are the estimates of the service life of the various types of capital goods. Satisfactory data, which would reveal how long various types of capital goods have remained in production in substantially unaltered form, do not exist.

TABLE VI

COMMODITY GROUPS AND WEIGHTS,
NON-RESIDENTIAL BUILDING MATERIALS
COMPONENT: BUILDING CONSTRUCTION - MANUFACTURING

COMMODITIES	Weights for Factories
Aggregate cement and concrete mix	0.119
Blocks, brick and building stone	0.096
Tile	0.033
Lumber and lumber products	0.054
Plumbing, heating and other equipment	0.229
Electrical equipment and materials	0.130
Steel and metal work	0.244
Hardware	0.032
Lath plaster	0.011
Roofing materials	0.029
Paint and Glass	0.016
Miscellaneous materials	0.007
Total	1.000

Source: Dominion Bureau of Statistics, Index of Non-Residential Building Materials 1935-1952.

In the outline of the perpetual inventory method given earlier, it was assumed that all investment expenditures on machinery and equipment represented the purchase of capital with a given service life. In making the assumption of one service life for all machinery purchased by an industry we are also in fact assuming that:

a) we can average the service life of all these kinds of assets into one representative figure; and

b) the annual expenditures by this industry contain unchanging proportions of each of the main kinds of assets.

> These are indeed extreme assumptions, and it is necessary that the reader recognize that they have been made and are implicit in all that follows. [8]

Another inherent difficulty which arises from the use of fixed service life estimates is that they ignore the possibility that the actual service lives of assets may be changing over time. One of the probable causes of such changes are the advances in technology which necessitate that firms make rapid and frequent adjustments in their productive processes if they are to remain competitive. While the service lives of machinery and equipment in certain industries may be shortening those of buildings because of improved construction and

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8 Wm. C. Hood and A. Scott, op.cit., p. 239.

design methods may be lenthening and thus it could be argued that on the whole the changes in one direction may to some extent be offset by changes in the opposite direction.

However, these and similar problems only serve to underline the basic need for periodic bench mark estimates to keep the perpetual inventory estimates of the stock of fixed capital up to date. Such benshwork estimates, which would entail obtaining information on the value and age of stocks of fixed capital by industry together with data on the service lifes of capital goods, would be quite expensive. But if the estimates are to be continued and improved, these surveys will have to be carried out.

4. The Growth of Fixed Capital

In constant 1949 dollar terms, total gross fixed capital formation in manufacturing rose from $443 million in 1946 to $1458 million in 1964. For construction type new capital goods, expenditures in this sector of the economy rose from $175 million to 355 million, while for machinery and equipment including capital items charged to operating expenses, expenditures increased from $268 million to $1003 million.

The distribution of investment expenditures in the manufacturing sector exhibited little change during the 1946 - 1958 period. Thereafter, expenditures on machinery and equipment began to account for an ever increasing share of total expenditures. This change in emphasis in the

distribution of expenditures on capital goods as between machinery and equipment and construction is quite apparent from Table VII and Chart V.

TABLE VII

GROSS FIXED CAPITAL FORMATION IN MANUFACTURING
PERCENTAGE DISTRIBUTION OF EXPENDITURES
CONSTANT 1949 DOLLARS
SELECTED YEARS

Year	Construction	Machinery and Equipment	Total
1947	35	65	100
1957	35	65	100
1960	29	71	100
1964	24	76	100

The distribution of investment expenditures in the manufacturing sector is not common to the economy as a whole. A study prepared for the Economic Council of Canada by Derek A. White, Business Investment to 1970, indicates that non-residential construction has accounted for the major share of investment expenditures in the post-war period.

> It is clearly apparent here that non-residential construction has become the dominant form of investment in the Canadian economy during the post-war years. Real residential investment, although providing visual evidence of enourmous growth in the form of post-war additions to the nation's housing stock, is actually the smallest of the three major forms of investment in terms of its contribution to total demand or the absorption of factors of production. [9]

Part of this movement in the post-war period is probably attributable to the replacement of various forms of construction, but a large part is clearly attributable to expansion of the capital stock in water transportation, hydro-electric, pipe-line and mining fields. A considerable proportion of this investment was of the "lumpy" variety resulting in a substantial addition to output capacity. Examples are the development of iron-ore mining and handling facilities, the St. Lawrence Seaway, the expansion of hydro-electric power for aluminum smelting, and oil field installations. A further contributing factor was the growth of expenditures on social capital such as schools, universities, hospitals, and municipal water works.

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9 D.A. White, Business Investment to 1970, Staff Study No. 5, Economic Council of Canada, (Ottawa, Queen's Printer, 1964), p. 4.

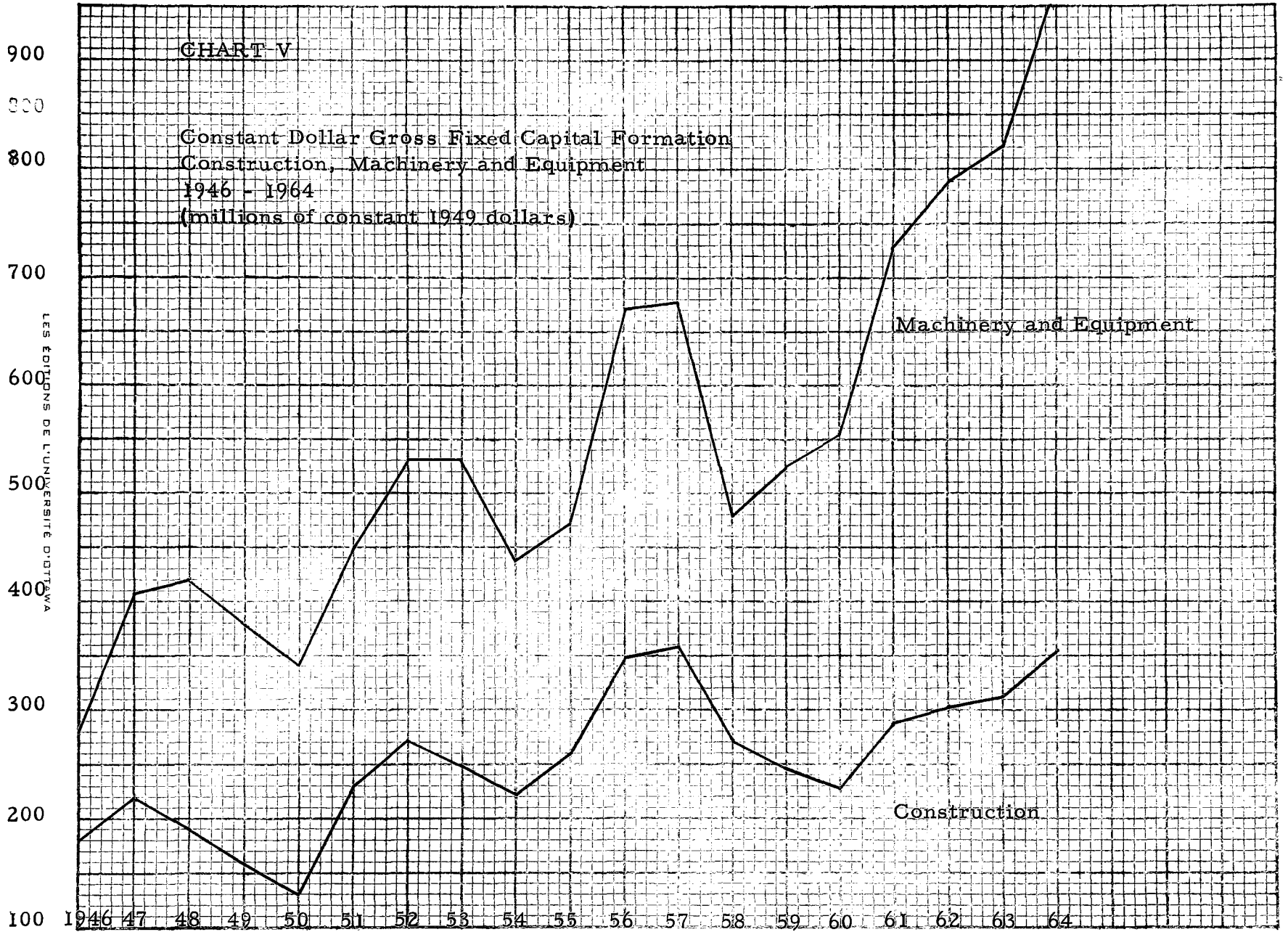
CHART V
Constant Dollar Gross Fixed Capital Formation
Construction, Machinery and Equipment
1946 - 1964
(millions of constant 1949 dollars)
Machinery and Equipment
Construction
900
800
700
600
500
400
300
200
100
1946 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
LES EDITIONS DE L'UNIVERSITE D'OTTAWA

Chart V illustrates the cyclical sensitivity of investment expenditures on both types of capital goods. It also illustrates the close relationship which existed between the cycles of both categories of capital equipment from 1947 to 1958. From 1958 the behavior of expenditures on these two types of capital goods is quite dissimilar with expenditures on machinery and equipment increasing more rapidly than those on construction. The larger amplitude of the cyclical changes by investment expenditures on machinery and equipment suggests that this type of investment expenditure is more sensitive to the various forces which precipitate fluctuations in business activity.

In the manufacturing sector, the stock of fixed reproducible capital in terms of 1949 dollars rose from $7,433 million in 1946 to $17,558 million in 1964. This increase in capital stock was in no way equally shared by all industries nor is the distribution of construction goods and machinery and equipment the same in all industries.

While the gross fixed capital formation data indicate that expenditures on machinery and equipment have been the predominant form of investment over the whole period, the gross stock data indicate that only since 1957 has machinery and equipment stock accounted for more than 50% of the total stock of fixed capital in manufacturing. This apparent contradiction is explained by the relatively short service life of machinery and equipment. This trend which is evident over the whole period is one which is common to the economy as a whole.

TABLE VIII

CHANGES IN GROSS FIXED CAPITAL STOCK
IN THE MANUFACTURING SECTOR
1946-1964

INDUSTRY	Change in Construction Capital Stock %	Change in Machinery and Equipment Capital Stock %	Change in Total Stock %
Foods & Beverages	102.2	177.7	140.8
Tobacco, Rubber & Leather	45.6	222.9	105.8
Textile	7.2	108.6	60.2
Clothing	- 36.0	205.1	35.9
Wood	8.4	222.5	87.8
Paper	52.2	329.8	149.4
Printing	78.8	89.8	85.4
Iron & Steel	67.5	292.4	175.2
Non-ferrous Metals, and Electrical	102.5	125.2	114.2
Transportation Equipment	17.9	127.5	64.7
Non-metallic Minerals, and Products of Petrol & Coal	208.2	461.4	265.4
Chemical Products	95.8	621.3	226.6
Miscellaneous Manufacturing	63.2	275.0	132.9
Average	68.1	250.7	126.5

Source: Dominion Bureau of Statistics, Preliminary Estimates of Fixed Capital Flows and Stocks, Canada, 1946-1960.

> Finally in Canada the same trends are noticeable. Investment estimates measured in 1949 dollars, suggest that in 1911 the expenditures by industry on construction was four times that of the expenditure on machinery and equipment. By the late 1920's, however, the figures in the two series were approximatly equal, and in the 1950's the constant-dollar expenditures on machinery and equipment ranges from one-and-a-half to two times the expenditure on construction. In 1926 the gross stock of industrial structures was almost three times that of the equipment gross stock, whereas by the late 1950's the stock of machinery and equipment had increased to 80% of the construction stock. This increase is particularly impressive when the low rate of discard of construction goods is remembered. [10]

Except for the clothing industry all sectors recorded increases in their stocks of both types of capital over the 1946-1964 period. Detailed tables on the size of the capital stock in each industry are given in the appendix to this chapter. However, Table VIII gives an indication of the changes which occured in the manufacturing sector over the period.

Non-metallic Minerals and Products of Petrol and Coal, Non-ferrous Metals and Electrical Products, and Foods and Beverages industries were the industries which recorded the largest percentage changes in their stocks of construction capital goods.

On the other hand, Chemical Products, Non-metallic Minerals, and Products of Petrol and Coal, and Paper Products were the industries which exhibited the greater percentage changes in their stocks of machinery and equipment.

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10 Wm. C. Hood and A. Scott, op.cit., p. 276.

Thus some industries which gave evidence of large increases in one type of capital stock showed little if any change in the other. An example of this is the clothing industry which increased its stock of capital in machinery and equipment by 205% over the 1946-64 period while its stock of construction-type capital goods declined by 35% over the same period.

From the volume indexes of the constant dollar gross fixed capital stock in the manufacturing sector, which are presented in the Appendix, it can be seen that the cyclical sensitivity of expenditures on gross fixed capital formation has not been transmitted to the estimates of capital stock. The explanation of this behaviour probably lies in the fact that the yearly additions to the stock of fixed capital are quite small compared to the size of the total stock thus variations in the magnitude of the former have little effect on the aggregate stock.

In conclusion, it can be stated that the value of the estimates of gross fixed capital stock depend largely upon the validity of the estimates of service life used in their construction. Thus until surveys of industry are undertaken to determine the validity of these lives it will be quite difficult to make a critical evaluation of the estimates they are used to construct.

In general, however, it can be stated that the stock of fixed capital in manufacturing has shown a substantial increase over the 1946-1964 period and the industries which comprise the manufacturing sector have shared in this

increase in varying proportions depending upon their needs and competitive abilities.

CHAPTER V

ESTIMATES OF TOTAL FACTOR PRODUCTIVITY

This chapter brings together all the component parts of the productivity ratio which have been discussed previously with a view to deriving the estimates of total factor productivity and analysing the results so obtained. It will also investigate the question of wages and productivity changes in the various industries which make up the manufacturing sector.

I. Derivation of the Estimates.

The 'total factor' productivity estimates derived for each industry and for the manufacturing sector as a whole were obtained by dividing a real output index by the weighted indexes of capital and labour. The basic formula used throughout this thesis may be expressed as follows:

$$\text{Productivity Index} = \frac{\text{Real output index}}{\frac{w(\text{index of man-hours}) + w(\text{index of real capital stock})}{\Sigma w}}$$

This method yields an annual index of productivity for each industry in the manufacturing sector. On the basis of the data so obtained it is possible to trace the year-to-year productivity changes in each industry as well as the average changes over the 1946-1964 period. It is also possible to compare the rate of increase between industries

and for the manufacturing sector as a whole.

The numerator of the productivity ratio is, for reasons outlined in Chapter II, the index of industrial production. For reasons of comparability with the input data it was necessary to combine the Tobacco and Tobacco Products, the Rubber Products and the Leather Products industry indexes into one index of industrial production. For similar reasons the Products of Petroleum and Coal and the Non-metallic Mineral Products indexes along with the Non-ferrous Metal Products and Electrical Apparatus and Supplies indexes were combined to form two seperate indexes. These distinct industrial production volume indexes (1949 = 100) were combined on the basis of each industry's relative contribution to Gross Domestic Product at factor cost in the 1949 base year.

The denominator of the 'total factor' productivity estimates prepared for this study include both labour and capital. In order to combine both these inputs for the derivation of the estimates it has been necessary to express them in common units.

> Obviously, manhours cannot be combined with dollars of tangible capital without translating each of them into comparable units. The appropriate unit is a dollars worth of services in the base period. [1]

If, for example, a man-hour of labour in a given industry commands $1.25 in the base period, and $100 of capital command $5.00 of net revenue per year (whether in rent, profits or interest) then we can say that the $100 of capital is equivalent to 4 man-hours.

The hourly renumeration assigned to labour was wages and salaries of the industry in the base year. The weight given to wages and salaries within an industry depended upon the relative number of hours worked by each employee group in the base year. These data were obtained from the Dominion Bureau of Statistics publication, Earnings and Hours of Work in Manufacturing.

The rate of return to capital decided on for use in this thesis is the average yield on new long-term (13-15 years) issues of industrial bonds. These data are published monthly by McLeod, Young, Weir and Company Ltd., and relate to a small group of selected

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1 Solomon Fabricant, Basic Facts on Productivity Change, (Occasional Paper 63; New York: National Bureau of Economic Research, 1959), p. 9.

corporations. For purposes of this thesis an average of the yields in the base year were used.

The technique of translating hundred dollar units of capital into equivalent hours of labour was applied to each of the industries of the manufacturing sector in the 1949 base year. Using the data so obtained it was then possible to derive weighting factors for the labour and capital input indexes. These weights are designed to reflect, for each industry in the manufacturing sector, the relative importance in terms of man-hours of the labour and capital inputs. However, since the use of labour far exceeds the use of hundreds of dollars of tangible capital, labour as a whole received a much greater weight than did the capital input.

The indexes of productivity derived using the technique outlined above were found to be very sensitive to cyclical fluctuations. For reasons developped in chapter one it was felt that the influence of the fluctuations in business activity should be eliminated. This was achieved by using a five year moving average - which interval corresponds roughly to the average length of the business fluctuations. [2]

2 The average length of cyclical phases in Canada during the 1946-1965 period has been 12 months for the contraction and 36 months for the expansion. See Economic Council of Canada, Second Annual Review, Towards Sustained and Balanced Economic Growth, (Ottawa, Queen's Printer, December 1965), p. 147.

2. Analysis of the Estimates.

A special interest is attached to over-all productivity indexes as the best available measure of net changes in the productivity of the manufacturing sector as a whole. In effect, the index of productivity in the manufacturing sector is a weighted average of the productivity indexes for the various industries. The component-industry measures show considerable dispersion and irregularity of movement. Only by a study of the aggregate measure can we see the net effect of industry productivity changes and the degree of regularity of the forces promoting improved performance in the sector as a whole.

Between the terminal years of the period 1946-1964, productivity in the manufacturing sector increased by 51.4 per cent. This percentage increase over the rate prevailing in 1946 yields an average annual increase over the whole period of approximately 2.7 per cent. Since real output, as measured by the index of industrial production, in the manufacturing sector increased by 121 per cent over the 1946-1964 period or by an average of 6.4 per cent per year, it is evident that about two thirds of the growth in output was accounted for by additions to labour and capital while one third was contributed by increases in the efficiency with which the inputs were utilized i.e. productivity. The relative importance of productivity in the

generation of increased output has been still greater in recent years.

The productivity estimates derived for the manufacturing sector as a whole compare quite favourably with the findings of the Dominion Bureau of Statistics as released in the publication Indexes of Output per Person Employed and per Man-Hour in Canada, Commercial Nonagricultural Industries, 1957-63. This study found the average output per man-hour in the manufacturing sector of the economy to be 3. 1 per cent per year over the 1947 - 1963 period.

While this similarity in the results is of interest, care should be taken not to attach too great an importance to it since there is a considerable difference in the coverage and techniques of measurement used in these two productivity studies. In addition, the fact that the Dominion Bureau of Statistics study does not make allowance for the contributions of capital to the creation of output also adds to the differences in the resulting estimates. However, the similarity of results can legitimately be taken as broad evidence of the validity of the results obtained in this thesis.

In the manufacturing sector as a whole, the growth of productivity has been relatively stable over the period under consideration. This relative stability is illustrated in Charts VI and VII. It is notably more stable than the growth patterns of the individual

component industries because most of the ratios tend to be offsetting. The offsetting nature of the divergent industry rates may be in part a result of random factors and in part a result of interindustry shifts in resources.

Over the 1946-1964 period, the average deviation of the indexes of productivity from the corresponding five-year moving average indexes is 1.7 per cent. This is approximately 15 per cent of the average annual increase in productivity. Percentage year-to-year changes in real output and productivity at the aggregate levels are summarized in Chart VII and VIII.

Perhaps the most important point to be considered when studying the annual fluctuations in productivity estimates is whether and to what extent the measures have been influenced by cyclical variations in economic activity. Since the identification and timing of turning points are based on monthly or quarterly data, and since the downturns have been of short duration [3] and have not corresponded

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3 In the 1946-1964 period cyclical downturns have not lasted more than four quarters. Table 20-1 of the Report of the Royal Commission on Banking and Finance, identifies the downturns as running from the 4th quarter of 1948 to the 3rd quarter of 1949, from 2nd quarter of 1953 to 2nd quarter 1954, from the 2nd quarter 1957 to the 2nd quarter 1958, and from the 1st quarter of 1960 to the 1st quarter 1958, and from the 1st quarter of 1960 to the 1st quarter of 1961.

total MFG

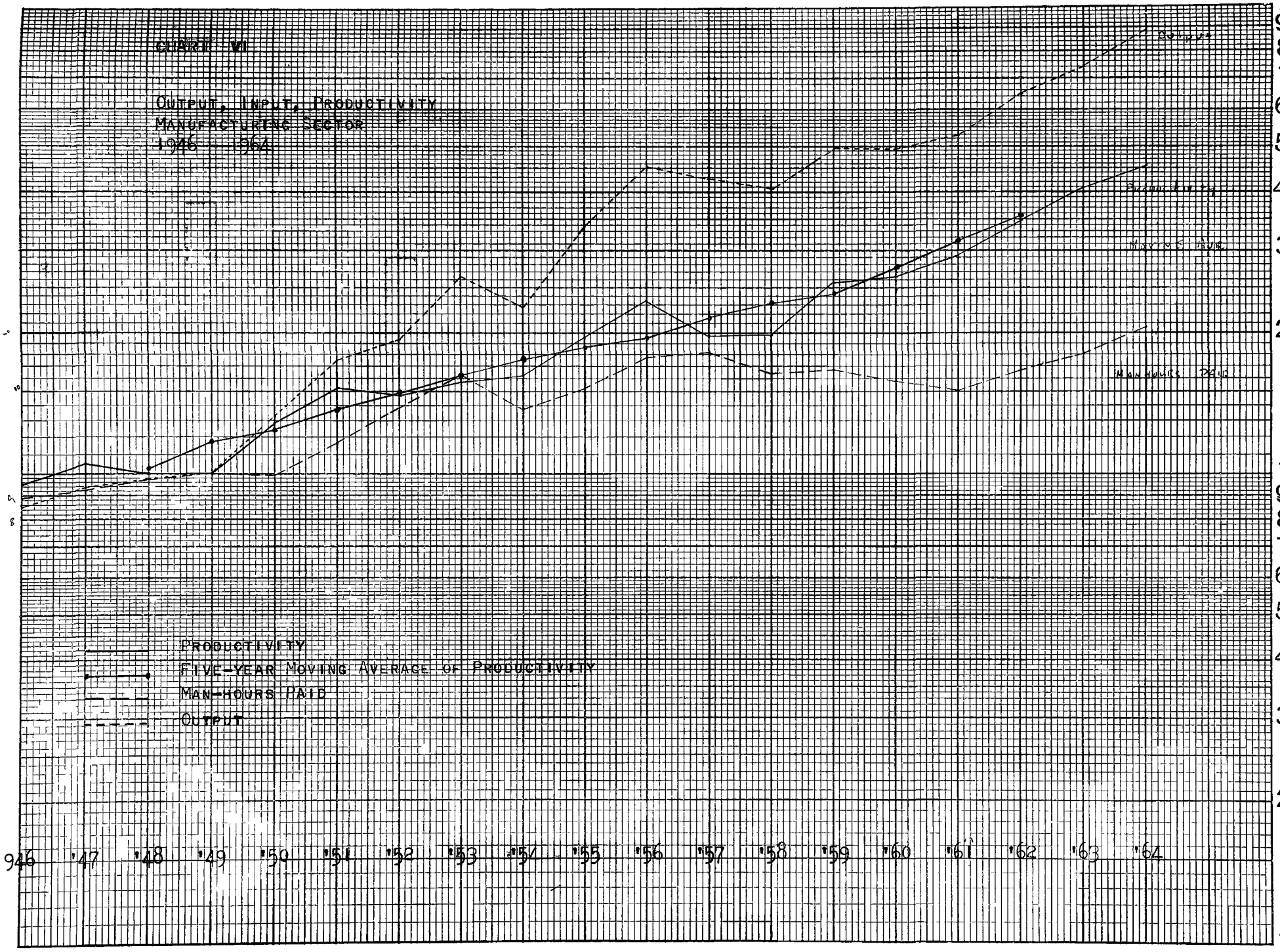
CHART VII
OUTPUT, INPUT, PRODUCTIVITY
MANUFACTURING SECTOR
1946 — 1964
OUTPUT
MAN-HOURS PAID
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
MAN-HOURS PAID
OUTPUT
1946
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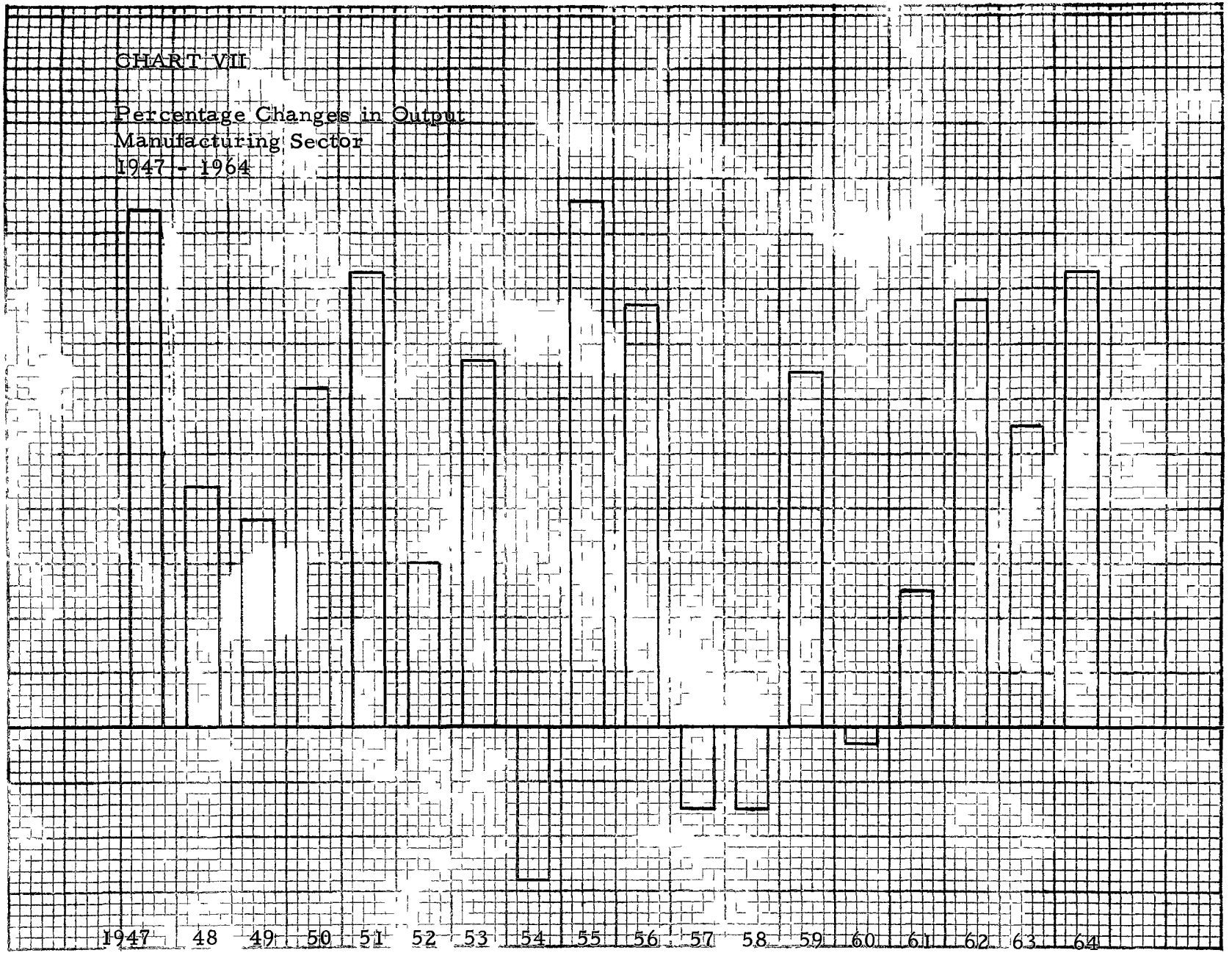
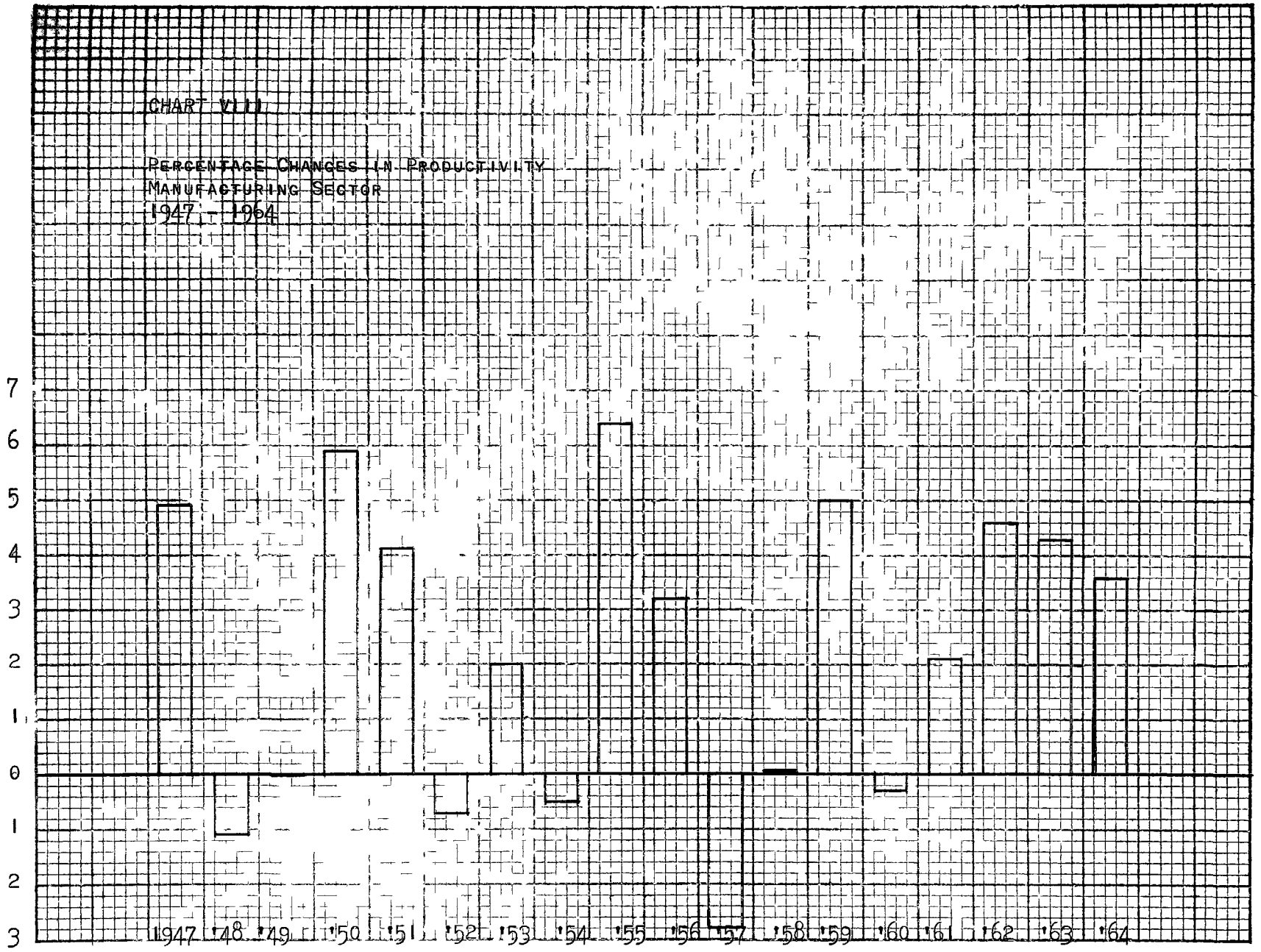
CHART VII

Percentage Changes in Output
Manufacturing Sector
1947 - 1964





to calendar years, annual data are fairly blunt tools for the analysis of cyclical movements. In addition, the data suggest that cyclical forces can be identified more easily in the movements of the output and input measures since their effects are partially offset when they are brought together to derive a series of productivity estimates.

However, prima facie, it appears reasonable to expect that year-to-year changes in productivity might reflect to some extent the influence of cyclical factors, and this has in fact been the case. The observations which can be made at sector level are equally relevant at the individual industry level as will be seen when the component industry productivity estimates are analysed.

The years which recorded the greatest increases in productivity in general corresponded to the years in which output rose at a higher than average rate. This was certainly true of 1950 and 1955 and to a slightly lesser extent of 1947, 1959, and 1962. Secondly the poorer productivity performances frequently coincided with periods where the growth of output was less than the average for the period or even negative. This was notably the case in 1954, 1957 and 1958.

It does not seem possible to conclude from these observations that a simple relationship exists between the movements of output and productivity since the record also shows a few notable exceptions from

the pattern described above. In 1952, for example, output increased over 1951 but the corresponding productivity estimates for that year declined in relation to 1951. This decline in productivity resulted from relatively large increases in labour input. The same conclusions can be drawn with respect to 1948 where once again output increased and the relative productivity declined. This decline was also the result of large increases in the labour input.

> It thus appears that the most suitable approach to the explanation of the cyclical behaviour of productivity lies in a comparison of the cyclical movements of its output and input components.

The identification of trend in any time series is usually looked upon as an uncertain exercise even under the most favourable conditions. In the present case the length of the period under consideration being quite short it does not favour this type of analysis. Bearing this limitation in mind the following observations can be made.

The productivity estimates for the whole manufacturing sector adjusted for cyclical influences as plotted in Chart VI seem to indicate a continued and steady growth over the whole period under

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4 Canada, Dominion Bureau of Statistics, Indexes of Output per Person Employed and Per man-Hour in Canada Commercial Non-agricultural Industries 1947-63, (Ottawa, Queen's Printer, 1965), p. 10.

consideration. There are, however, indications that this is not the case of the output and input components, where there appears to have been a break in the trend around 1956 or 1957. The break in trend has resulted from slower growth rates for both output and labour input. Chart VI indicates that the growth rate of the labour input is now relatively slower than the growth rate of output. This fact suggests that productivity increases have become a relatively more important factor in the growth of output in the latter years of the period under review.

As the analyst leaves the measures of productivity for the total sector and examines those for the various constituent industries, he is struck first by the diversity of productivity movement. The industry rates of productivity change, while tending to cluster about their mean, show a considerable range of dispersion. The degree of dispersion is graphically represented in Chart IX over the 1946-64 period, the industries which comprise the manufacturing sector have recorded productivity increases which vary from 34. 2 to 91. 3 per cent. The average annual rate of productivity increase ranges from 1. 80 per cent in the Clothing industry to 4. 81 per cent in the Non-metallic Minerals and Products of Petroleum and Coal industry. While these two rates of change bracket the range of dispersion it should be noted

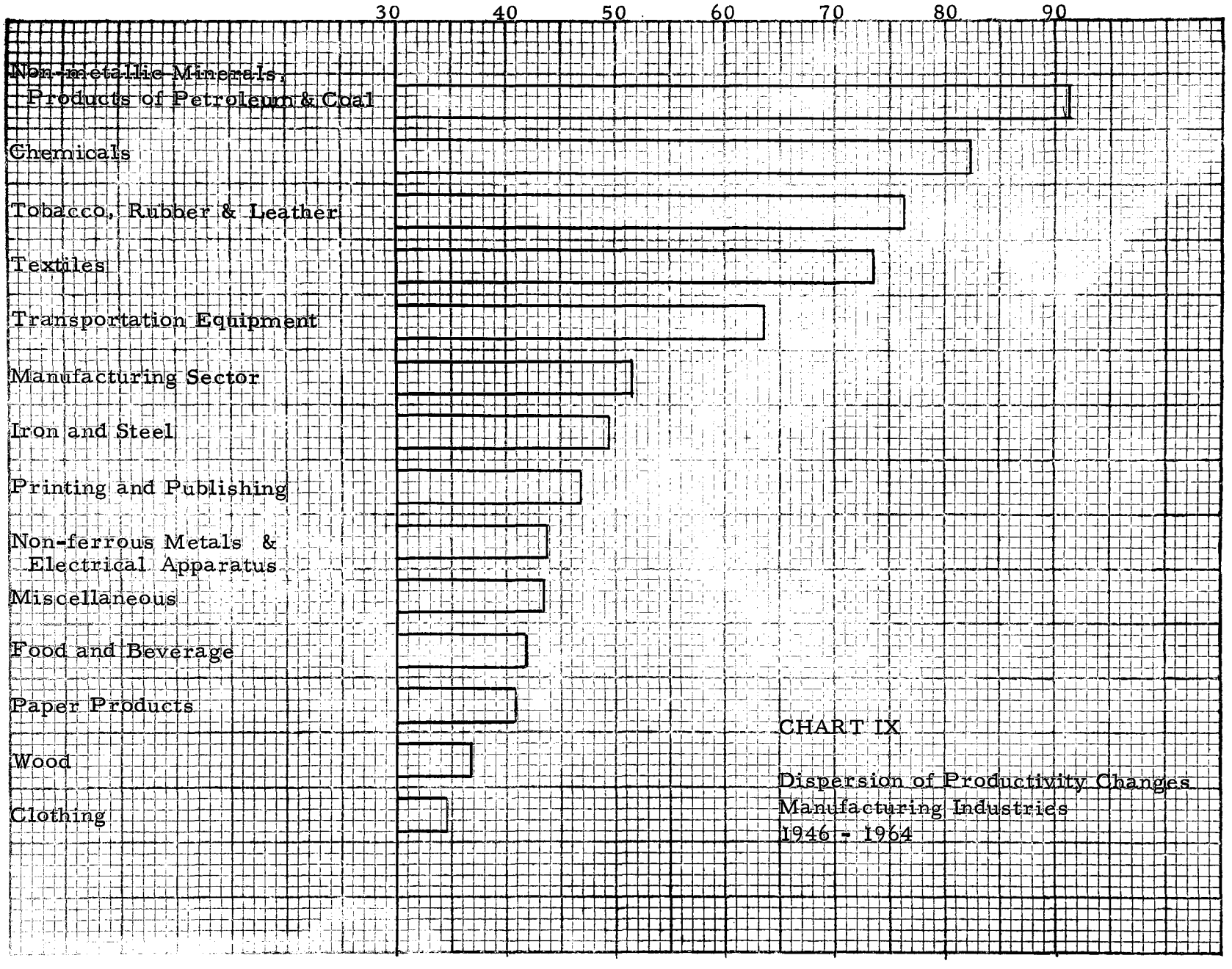


CHART IX

Dispersion of Productivity Changes
Manufacturing Industries
1946 - 1964

that the productivity rates of the majority of the industries closely parallel that of the manufacturing sector as a whole.

Table IX lists the total percentage increase in productivity over the period as well as the average annual increase in productivity and the weight factor applied to each industry. On the basis of this data it is possible to assess the importance and effect of the productivity of each individual industry in the performance of the manufacturing sector as a whole. For example the three industries, Non-metallic Minerals and Products of Petroleum and Coal, Chemicals and Tobacco, Rubber and Leather, which have exhibited the greatest increases in productivity have a combined weight which is slightly less than that of the Foods and Beverages industry which ranks tenth.

Table IX also includes the average percentage variation in the yearly productivity estimates. This column provides an indication of the variability of the productivity estimates in the individual industries. As in the case of the sector it can be stated that the forces which underlie these variations are largely cyclical. Again, as with the sector, it appears that the most suitable approach to the explanation of these cyclical variations lies in an examination of the movements of the output and input components.

TABLE IX

PRODUCTIVITY CHANGES IN MANUFACTURING
BY INDUSTRY 1946-1964

INDUSTRY	Total Change %	Average Yearly Change %	Average Variation %	Weighting Factor
Non-metallic Minerals and Products of Petroleum and Coal	91.31	4.81	4.4	4.42
Chemical Products	82.38	4.33	4.1	4.22
Tobacco, Rubber and Leather Products	76.33	4.02	5.0	4.31
Textile Products	68.65	3.61	5.1	6.08
Transportation Equipment	63.72	3.35	6.1	10.15
Iron and Steel Products	49.60	2.61	4.2	15.39
Printing and Publishing	46.71	2.46	2.9	5.29
Non-ferrous Metals and Electrical Products	44.83	2.36	3.5	10.75
Miscellaneous Manufacturing	43.47	2.29	2.8	1.69
Foods and Beverages	41.95	2.21	2.8	13.06
Paper Products	40.47	2.13	3.1	8.78
Wood Products	36.78	1.94	2.5	8.45
Clothing Products	34.20	1.80	3.6	7.41
Manufacturing Sector	51.42	2.71	2.7	100.00

It is interesting to note that the two industries which exhibited the largest gains in productivity were also those which recorded the most important increases in capital stock over the same period of time. For the remaining industries correspondence seems to be evenly divided between those industries which did exhibit similarity in growth patterns and those that did not. It would, however, be very difficult at this level of aggregation to ascribe any definite causality to this occurrence without knowing in detail the composition of the capital stock.

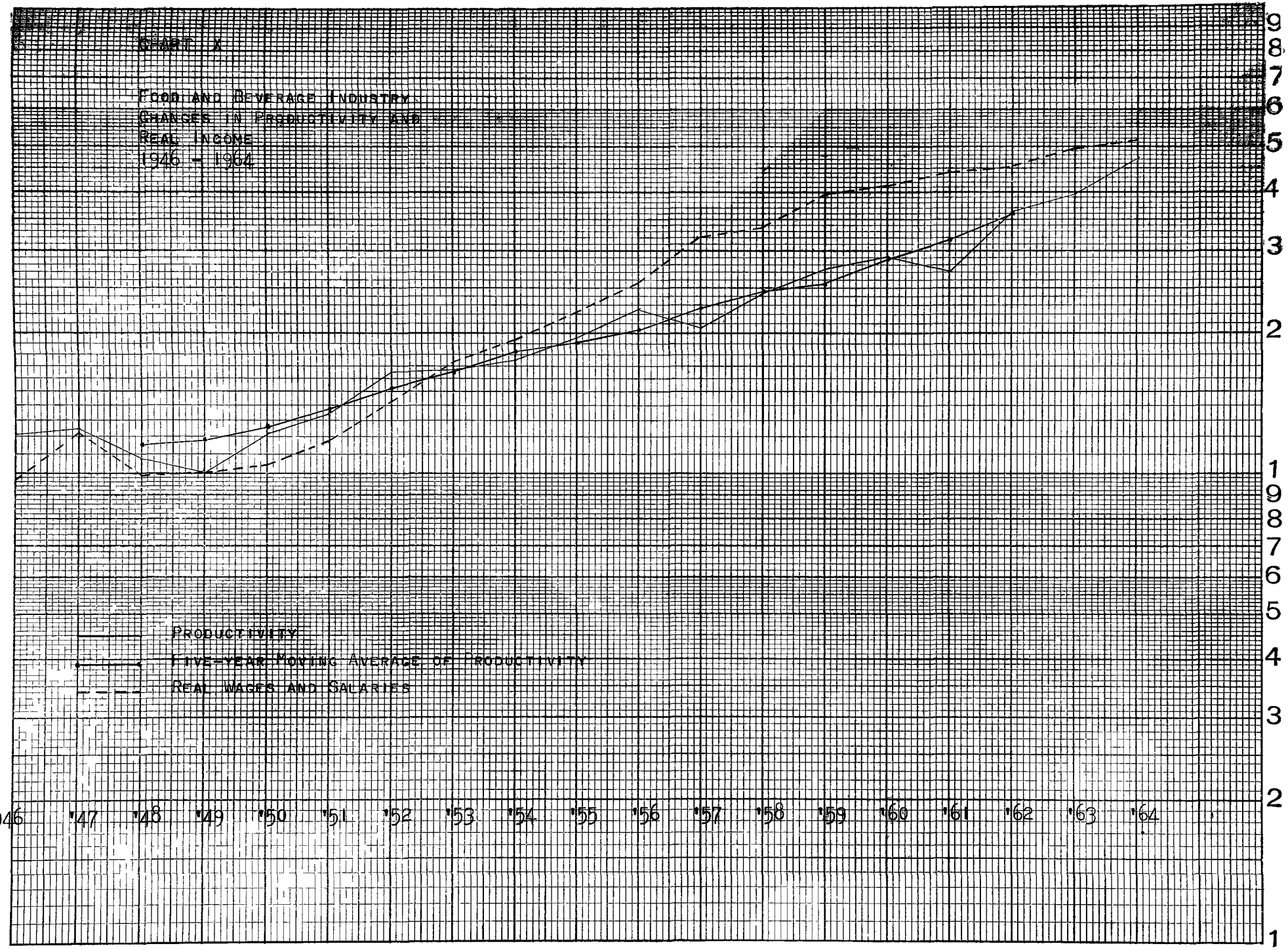
Notwithstanding the variability which exists in the estimates of productivity most of the industries in the manufacturing sector have exhibited a trend towards increasing productivity over the period under consideration. The clothing industry is the exception to the rule. Its five year moving average of productivity declined from 1957 to 1962 as a result of decreases in output. It now remains to be seen whether the dramatic increase in output which occurred in 1962 can be sustained without equally dramatic changes in factor inputs.

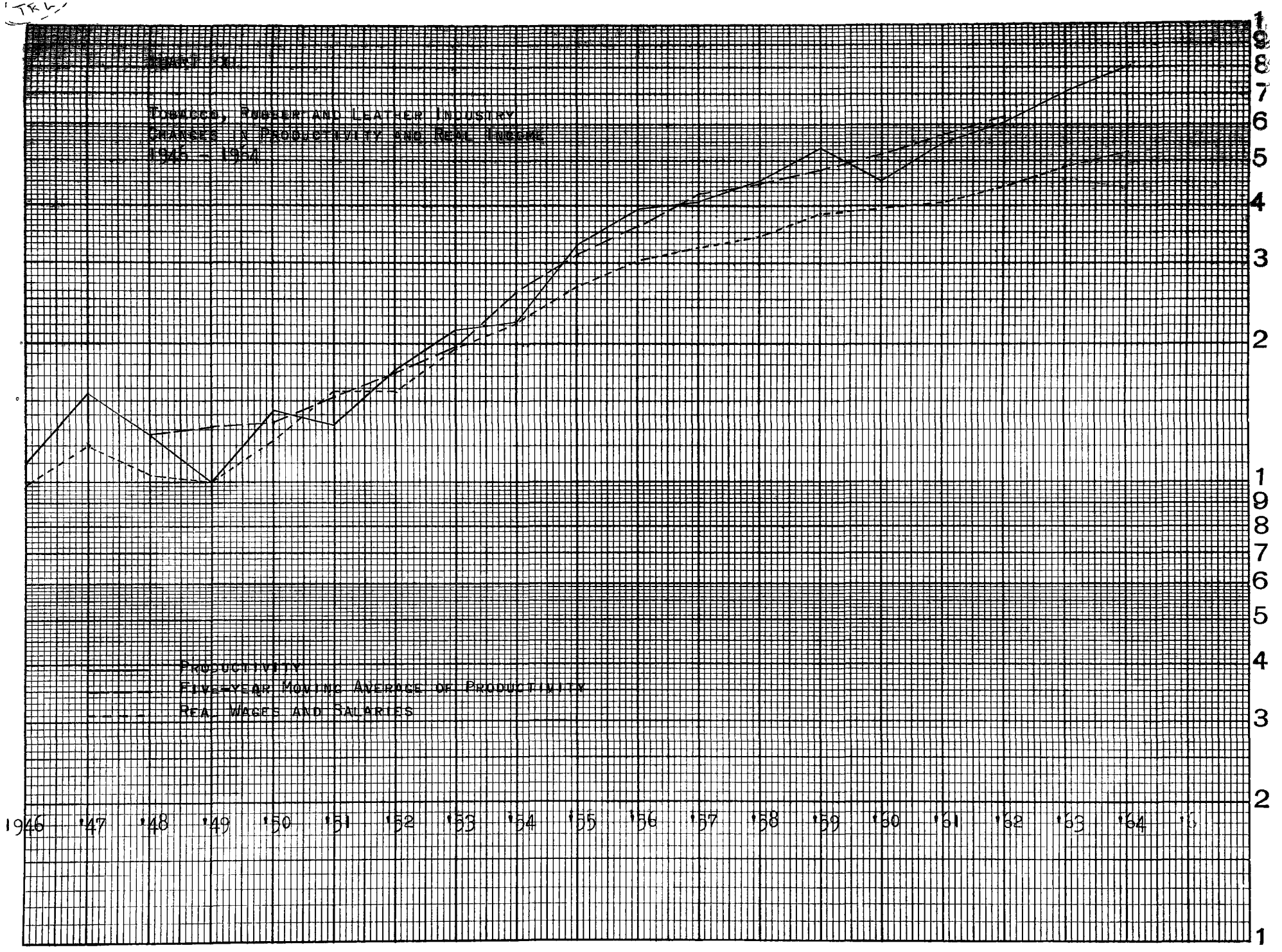
3. Productivity and Wages.

The possible use of productivity estimates in wage negotiations which was introduced in Chapter I will be covered here in greater depth. In recent years the use of this tool has gained

CHART X

FOOD AND BEVERAGE INDUSTRY:
CHANGES IN PRODUCTIVITY AND
REAL INCOME
1946 – 1964




TOBACCO, PRODUCT AND LEATHER INDUSTRY
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 - 1964
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
REAL WAGES AND SALARIES
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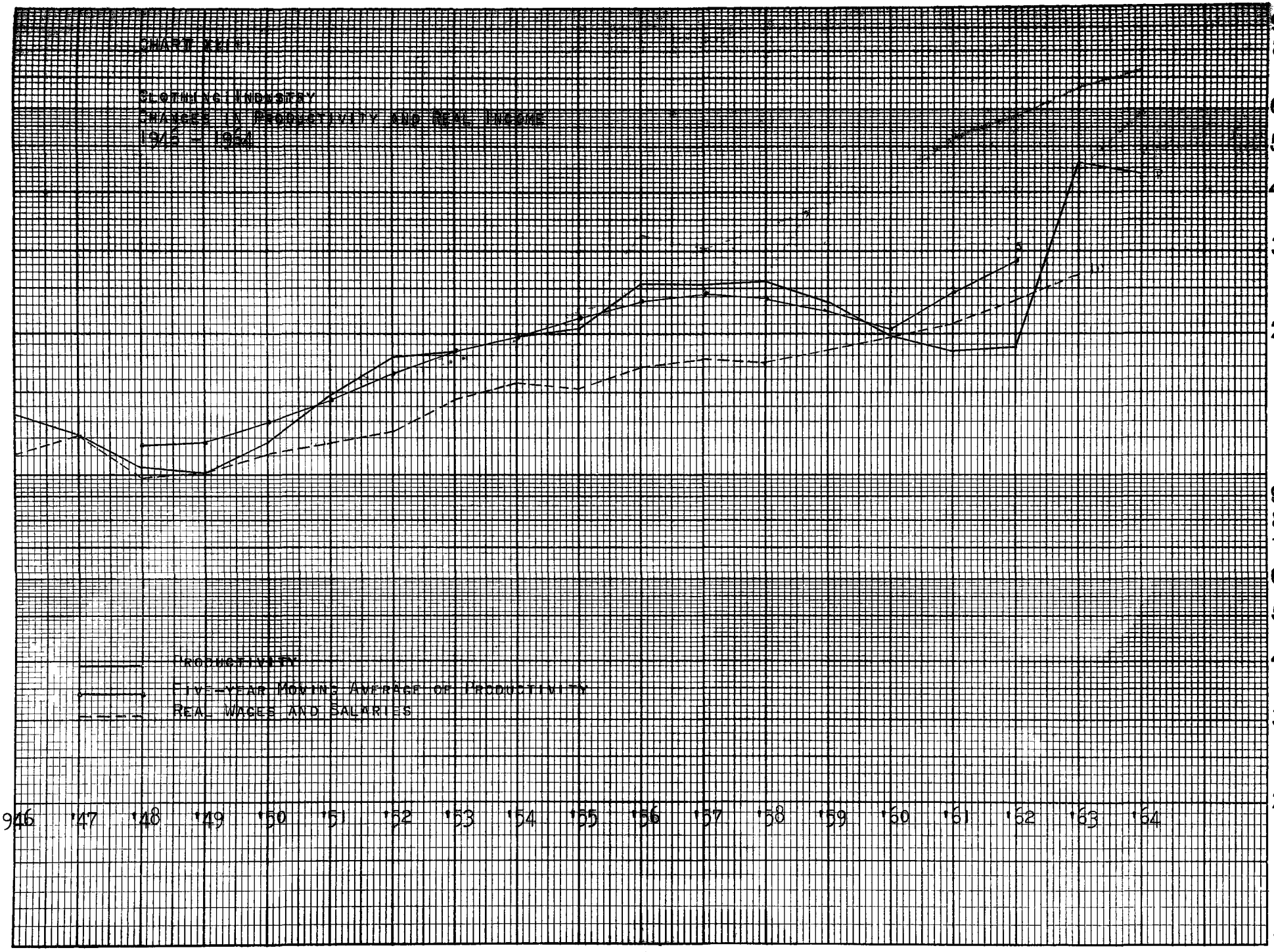
CHART XVII
CLOTHING INDUSTRY
WAGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
REAL WAGES AND SALARIES
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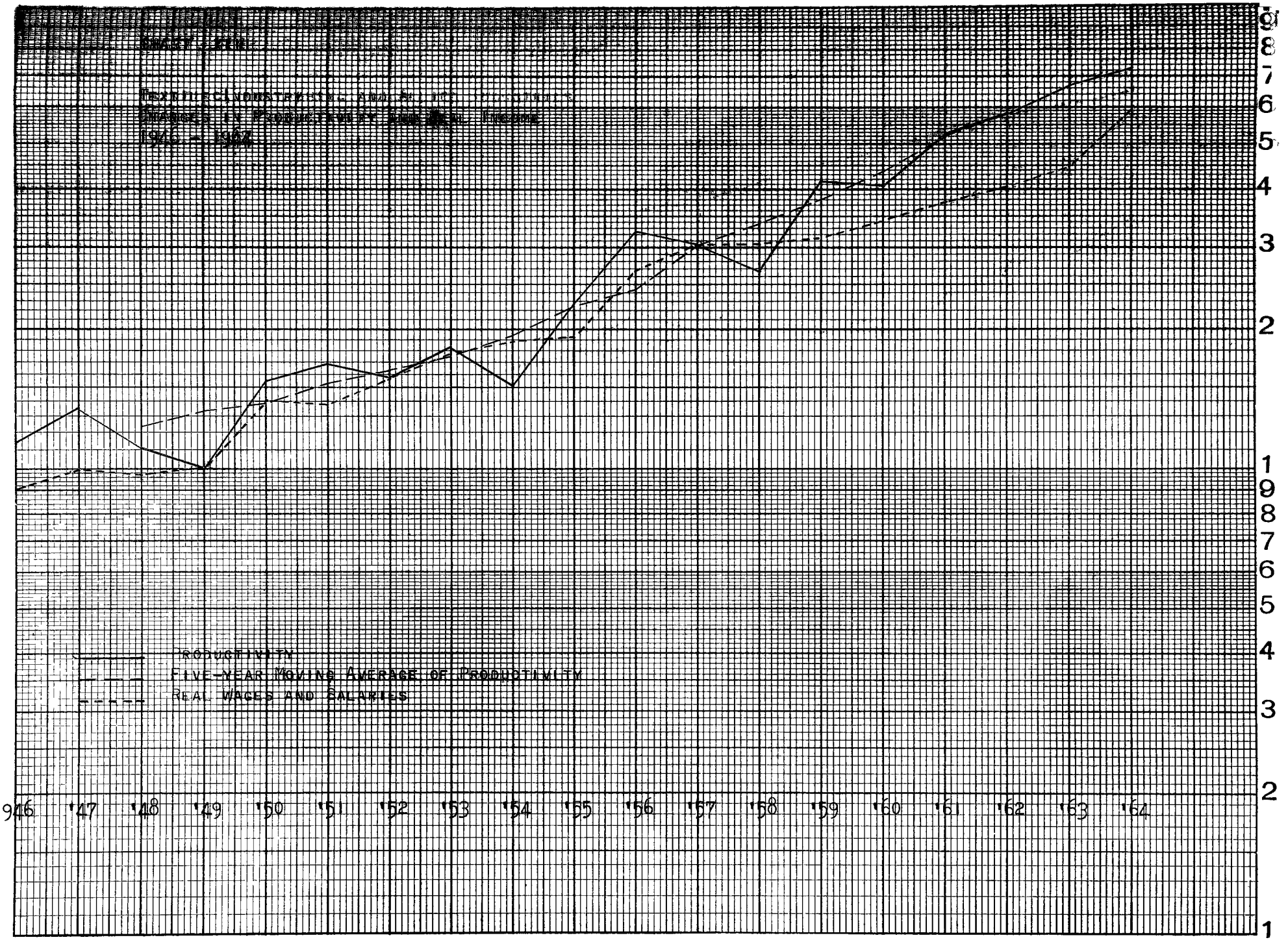
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
REAL WAGES AND SALARIES
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CHART XIV

PRINTING, PUBLISHING AND ALLIED INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964

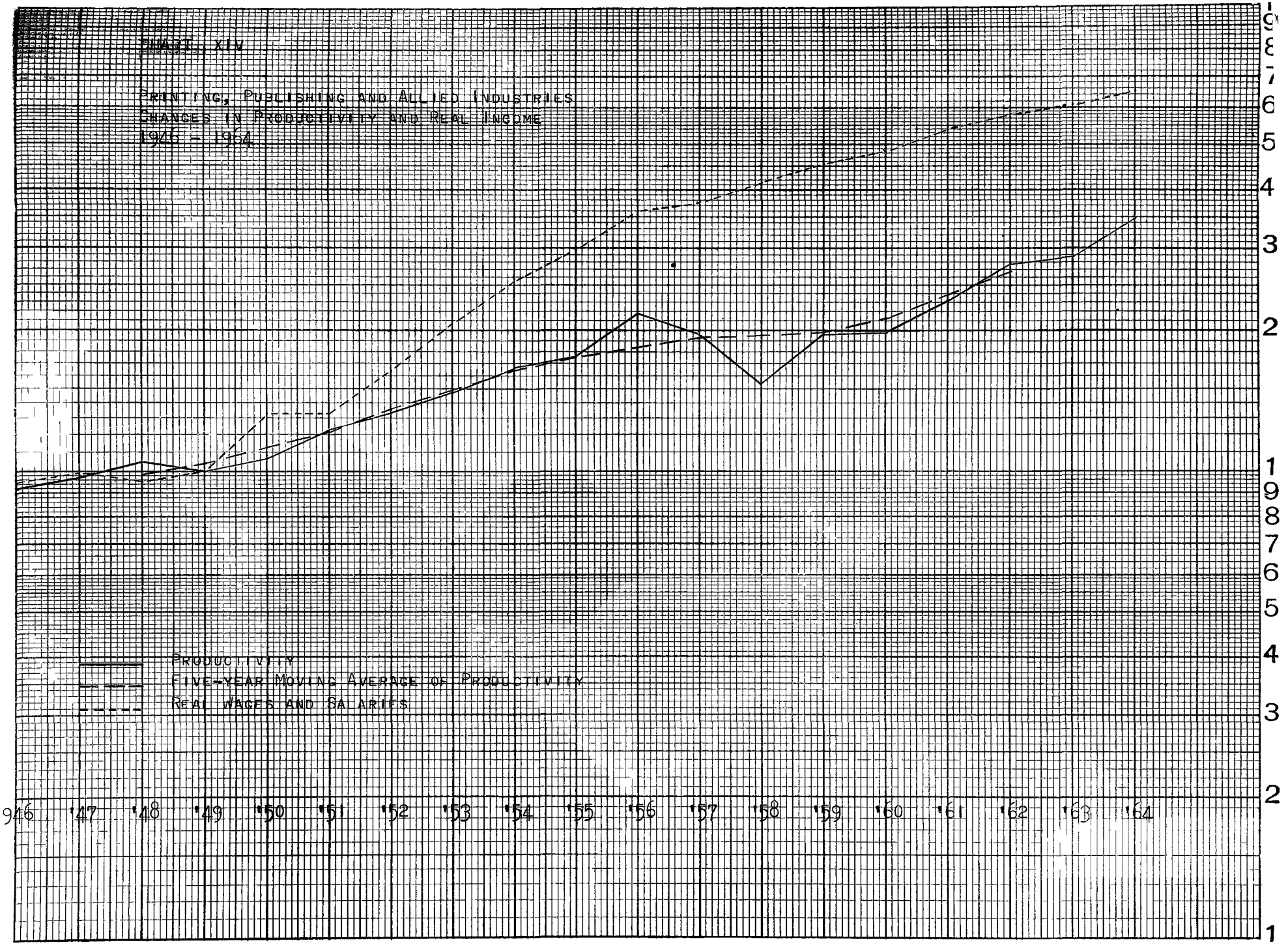
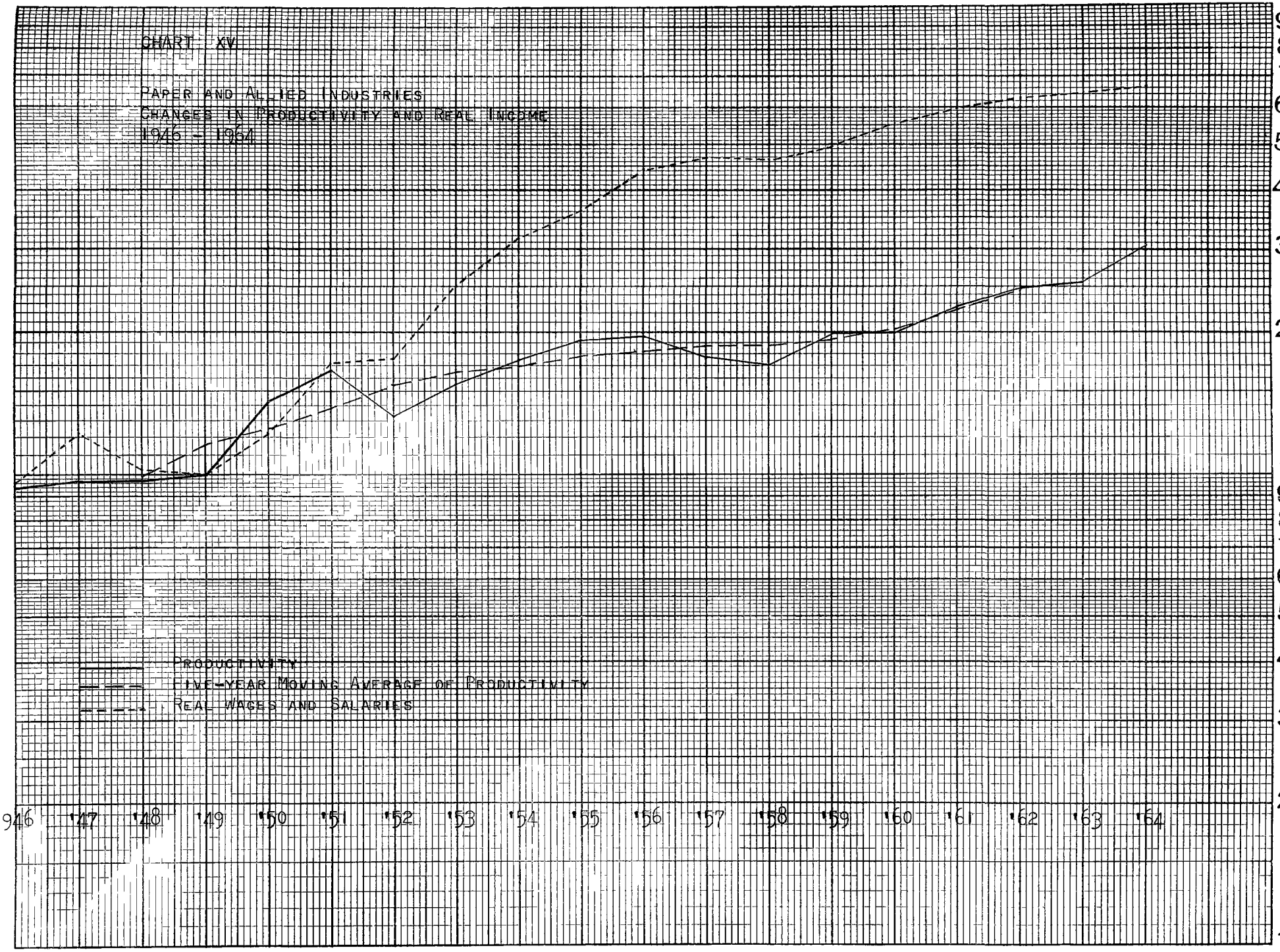


CHART XV

PAPER AND ALLIED INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 - 1964



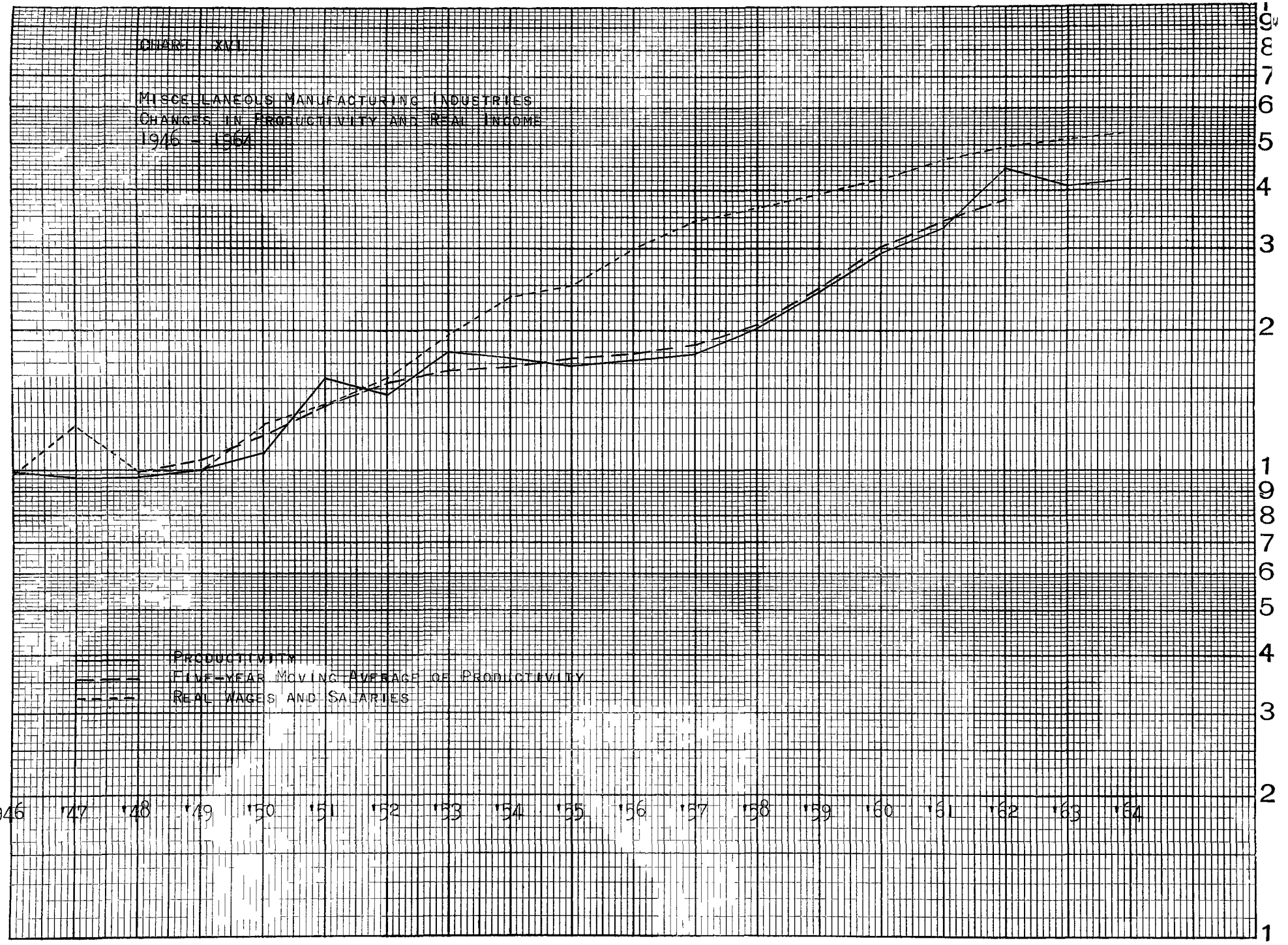


CHART XVI
MISCELLANEOUS MANUFACTURING INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
REAL WAGES AND SALARIES
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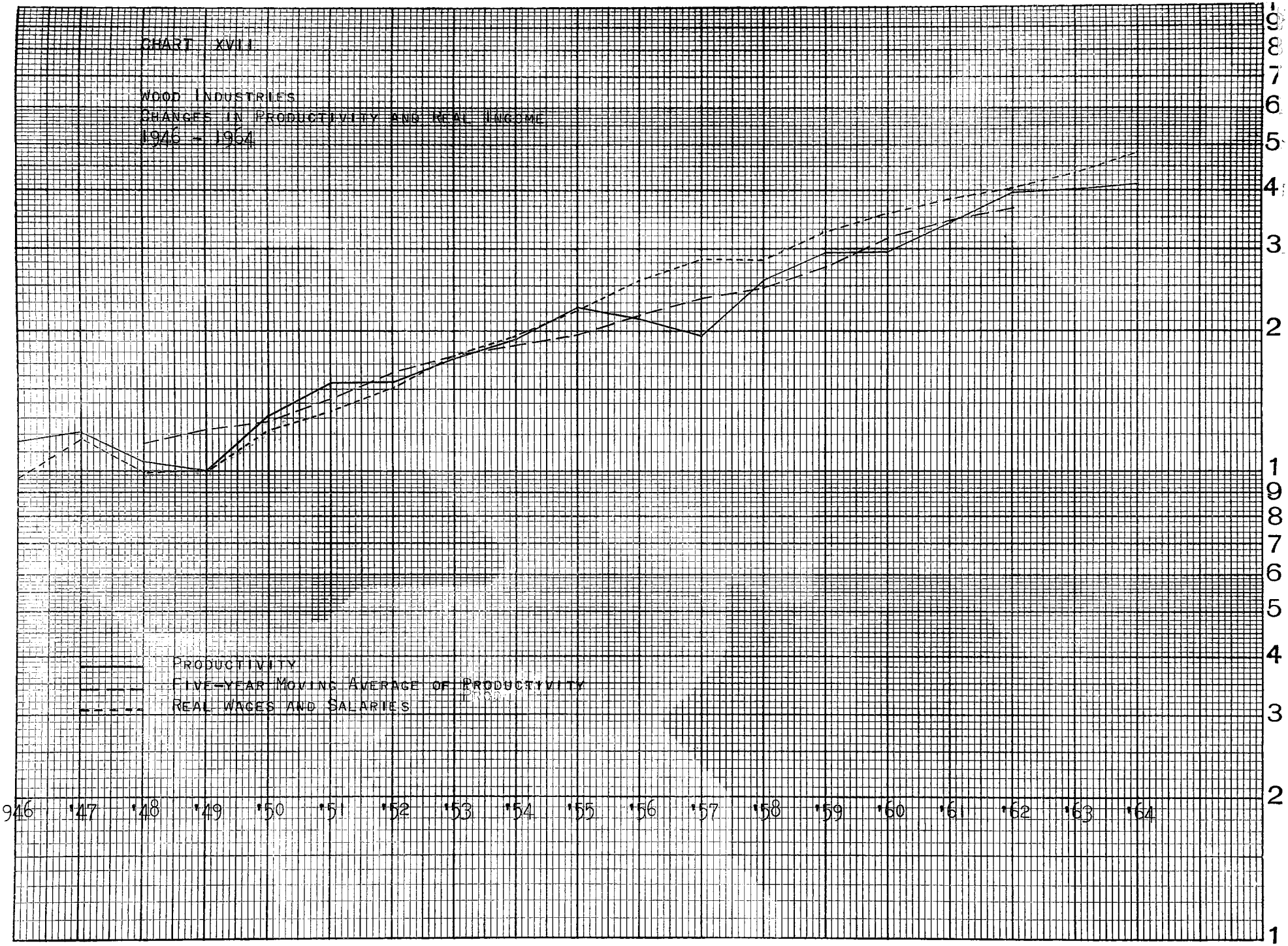
CHART XVIII
WOOD INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 - 1964
PRODUCTIVITY
FIVE-YEAR MOVING AVERAGE OF PRODUCTIVITY
REAL WAGES AND SALARIES
1946 '47 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58 '59 '60 '61 '62 '63 '64
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CHART XVIII

IRON AND STEEL INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964

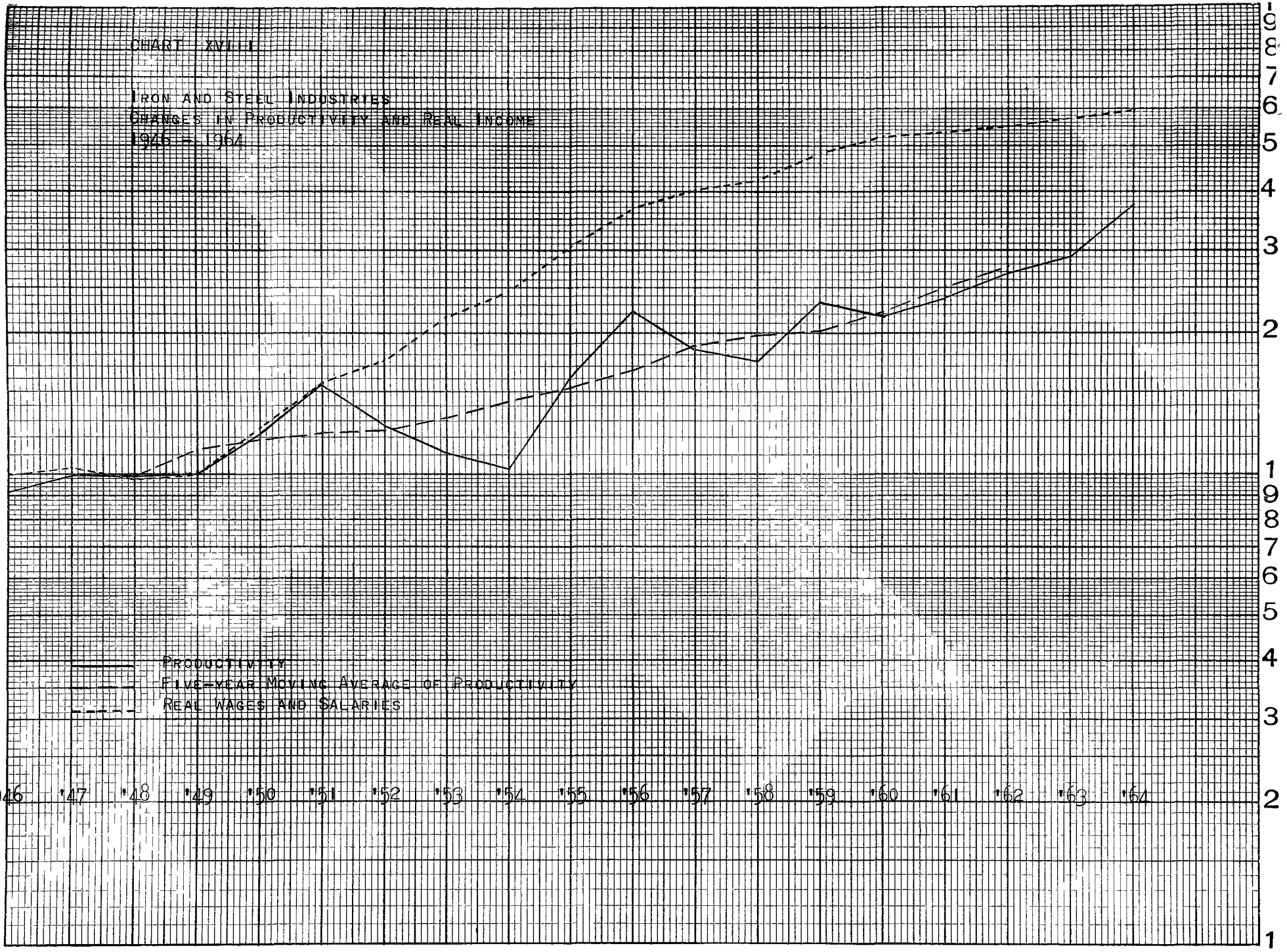


CHART XIX

TRANSPORTATION EQUIPMENT INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964

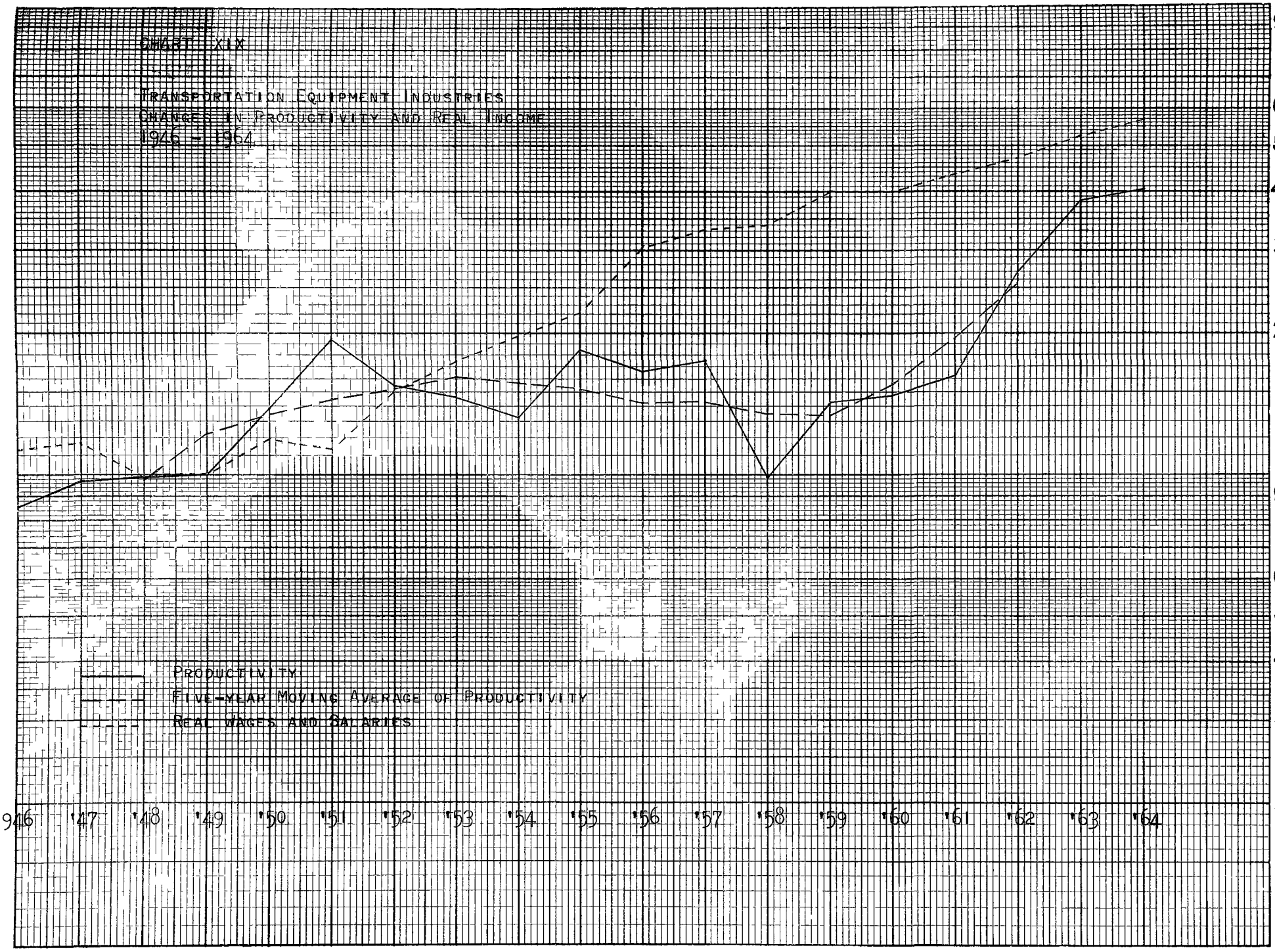


CHART XX

NON-FERROUS METALS AND ELECTRICAL PRODUCTS INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 – 1964

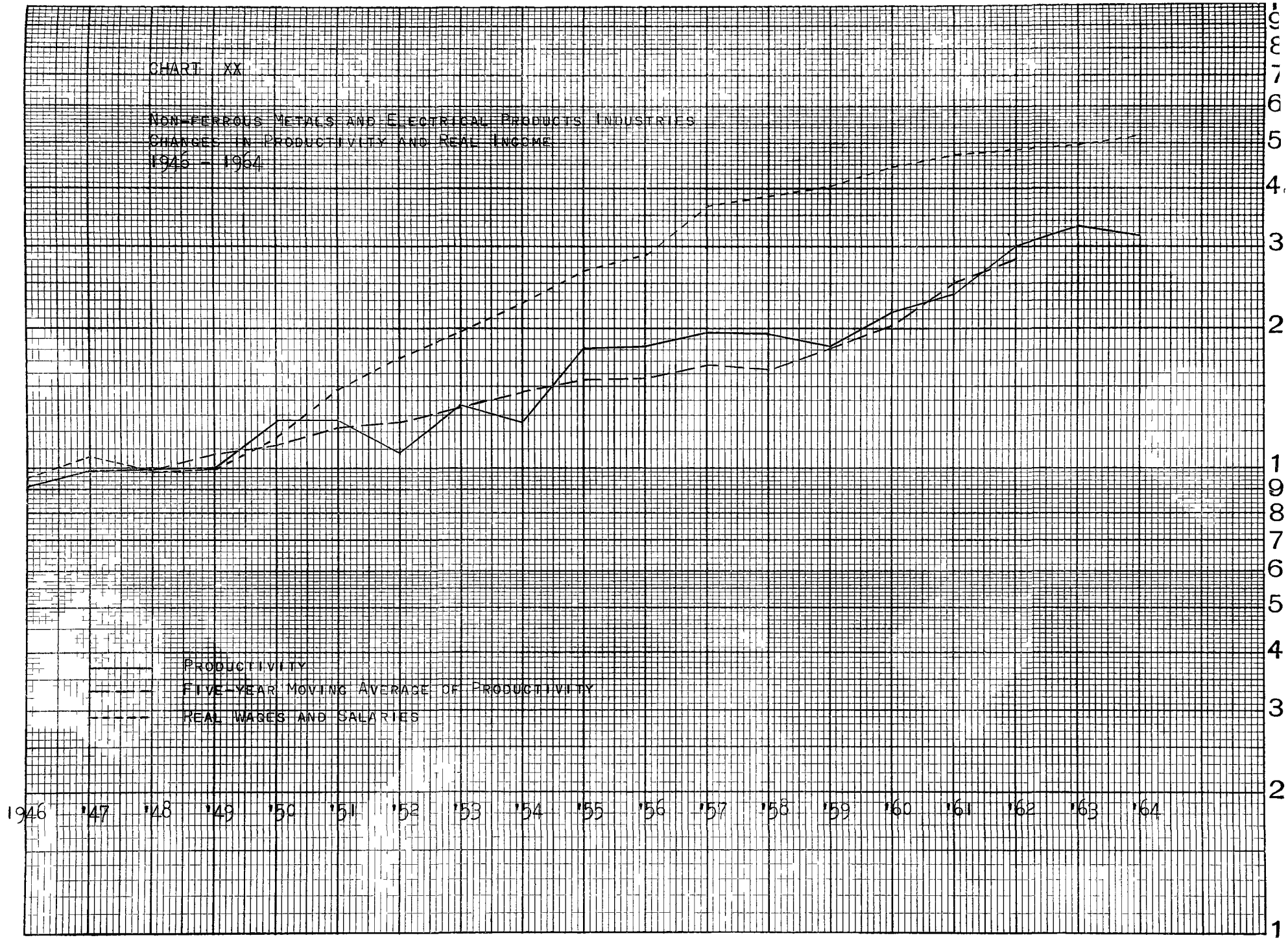


CHART XXIII

CHEMICAL AND CHEMICAL PRODUCTS INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 - 1964

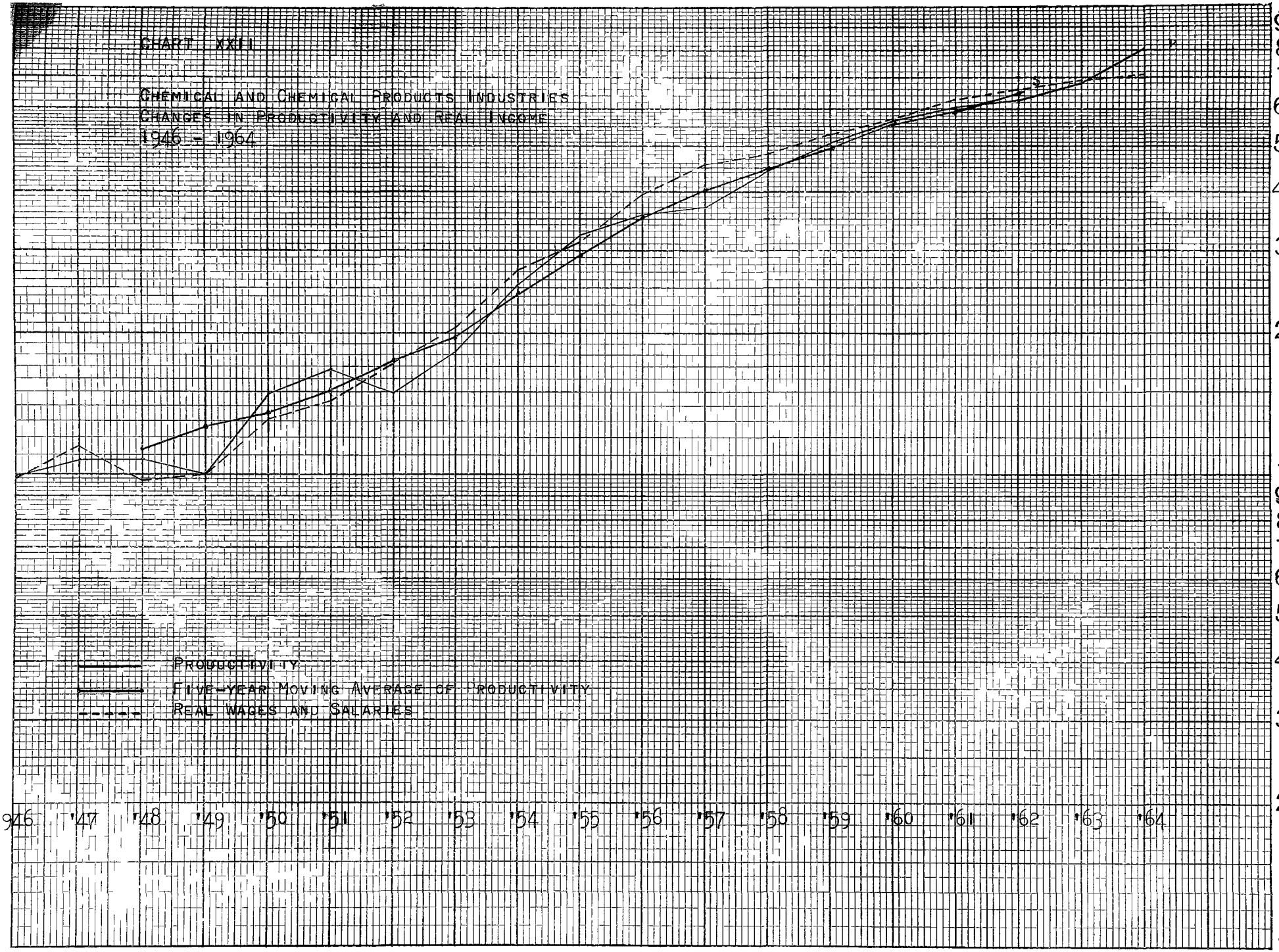
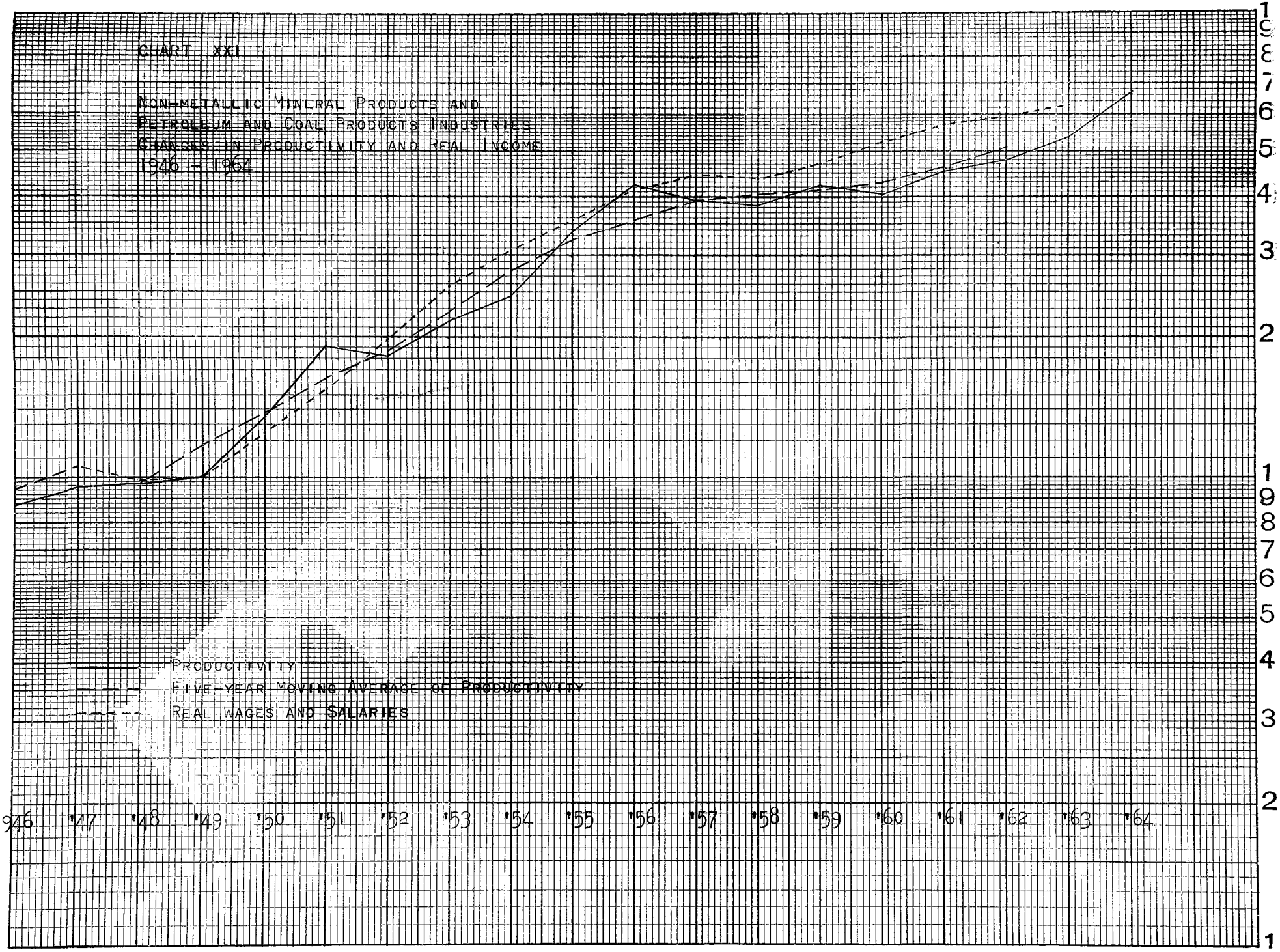


CHART XXI

NON-METALLIC MINERAL PRODUCTS AND
PETROLEUM AND COAL PRODUCTS INDUSTRIES
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 = 1964



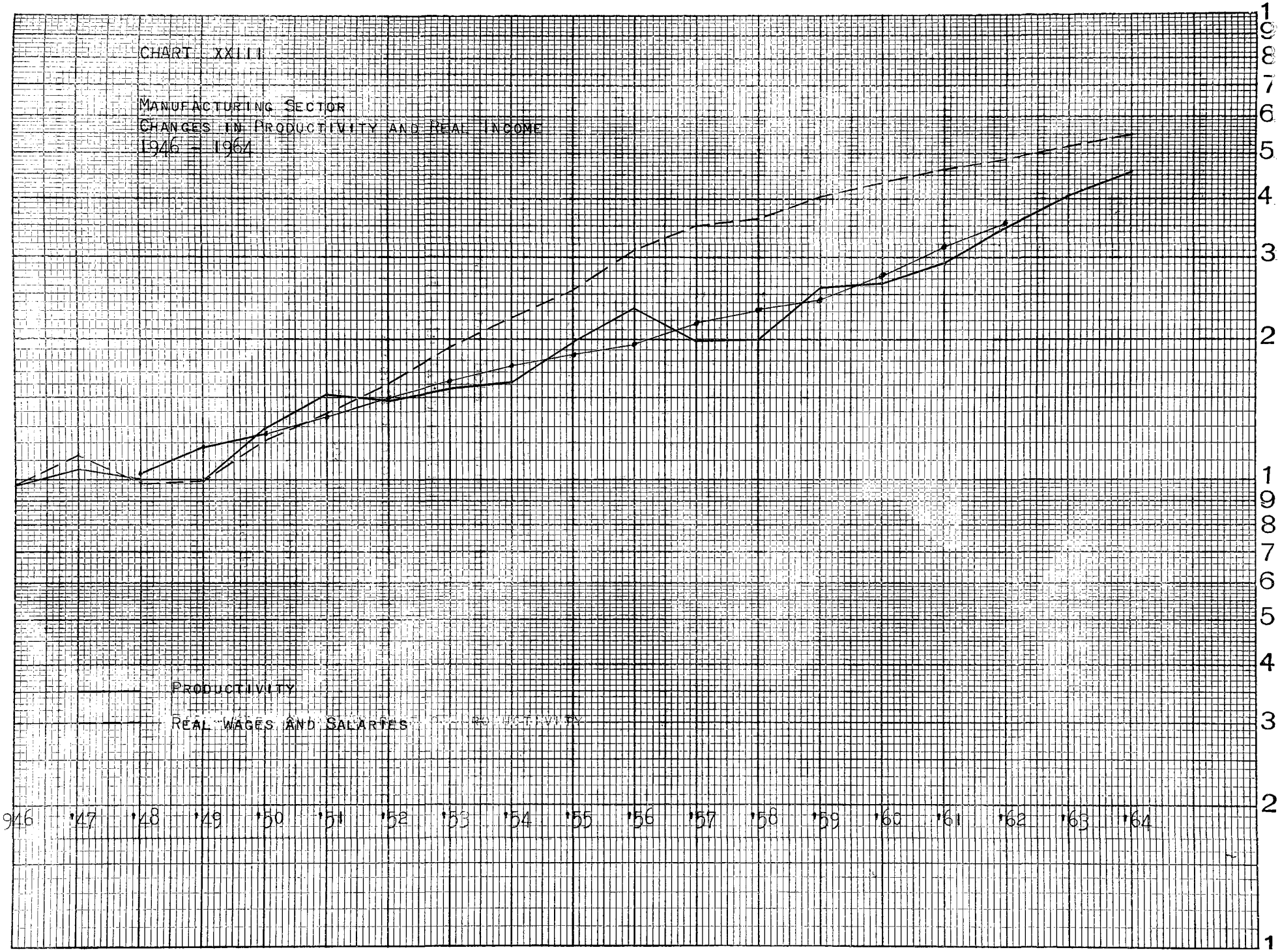


CHART XXIII
MANUFACTURING SECTOR
CHANGES IN PRODUCTIVITY AND REAL INCOME
1946 - 1964
PRODUCTIVITY
REAL WAGES AND SALARIES PER UNIT OF PRODUCTIVITY
1946 '47 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58 '59 '60 '61 '62 '63 '64
1 9 8 7 6 5 4 3 2 1

increasing acceptance among labour, management and government. Therefore, it is of interest to investigate the historical record of these variables in Canada.

Over the 1946-1964 period, real wages and salaries in manufacturing increased by 58.55 per cent over the rate prevailing in 1946. This is equivalent to an average annual increase of 3.08 per cent. Productivity during the same period increased by 51.42 per cent over 1946 or by an average rate of 2.71 per cent per year.

It is quite difficult to make generalizations on the basis of so short a period. Data for a much longer period is required to reveal any definite correlation. However, it can be said that the variables with which we are concerned while they indicate marked variations in detail, they both confirm the same general trend toward an improvement of a similar magnitude.

From the movements of productivity and real wages plotted in Chart XXIII it is quite evident that throughout much of the period, the gains realized in real wages and salaries have been greater than those in productivity. In considering these improvements in real earnings, it must be remembered that the statistics for wages and salaries do not include any allowances for certain fringe benefits

or reduced working hours. If the value of these non-monetary benefits were included it is evident that the resulting data would indicate that the well-being of workers in manufacturing had increased far in excess of that which could have been paid for by increases in productivity.

The question then remains, how have these gains in real income been financed? John W. Kendrick has proposed a possible answer:

> The basic explanation of the fact that real wages rose faster than productivity lies in the considerably faster increase in capital than in man-hours worked. ... As long as output per unit of capital rises more than the rate of return on capital, it is possible for real average hourly labour earnings to rise more than output per unit labour input.[5]

The behaviour of productivity and real wages in the individual industries gives ample evidence of considerable diversity. In the chemical industry, the Non-metallic Minerals and Products of Petroleum and Coal industry, Textiles industry, the gains made in real wages and salaries have closely paralleled the increases in productivity. On the other hand, the following industries:

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5 John W. Kendrick, "The Wage-Productivity-Price Issue", California Management Review, Spring, 1960, p. 44-45.

Non-ferrous Metals and Electrical Appliances, Transportation Equipment, Iron and Steel, Paper Products, Printing and Publishing and Miscellaneous Manufacturing have recorded gains in real wages and salaries which exceeded, in varying degrees, the gains realized in productivity. In this connection, it is interesting to note that increases in real capital stock in these industries have far exceeded the increases in the number of hours paid. According to J. W. Kendrick [6], an industry's gains in real wages can exceed those of its productivity where the above conditions prevail because then some of the returns which should be going to capital are being channelled to labour. However, this is not the only determining factor since the aforementioned conditions also apply to the industries where productivity and real wages move along parallel paths.

Finally, in the Clothing and Tobacco, Rubber and Leather industries, productivity increased faster than did real wages and salaries. It is difficult to analyse any of the movements of the Tobacco, Rubber and Leather industry since this group includes two

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6 John W. Kendrick, "The Wage-Productivity-Price Issue", California Management Review, Spring, 1960, p. 44-45.

very distinct methods of production. Rubber is a highly capital intensive industry while Tobacco and Leather are heavily weighted in favour of labour. Therefore with this group it is quite possible that the high productivity of one industry would be cancelled by large increases in employment or low output of the other industries.

With the Clothing industry the case is clearer. Here we have an industry where all three variables, productivity, real wages and increases in capital stock, are the lowest for the manufacturing sector. The low real wages probably stem from the fact that largely female labour is used and that most of the units of production are small.

Notwithstanding the diversity exhibited in the individual industries there still exists some semblance of trend in the sector. Individual industries are ranked by the size of wage increases over the period in Table X. It also ranks the industries by productivity. From this table we can see that, in general, industries with high real wages and salaries usually correspond to those with high rates of productivity. This is not to say that high productivity is the sole determining factor, but it has been an important contributing factor in these industries ability to pay high real wages. The high wages prevailing in these industries have forced low productivity industries

to follow suit. Pressure has been applied by unions and by the society as a whole.

As regards the use of productivity as a tool in collective bargaining it is essential at the outset to be aware of the difficulties that this course of action imposes before attempting the implementation of such a policy.

Before any attempts at linking productivity and wages can be made a measure of productivity must be decided upon and accepted by all those who will be affected by it. In this respect it is important to insure that the technique of measurement chosen takes full account of all the factors contributing to the creation of the output and that these various factors be given appropriate weights.

It appears to be dubious wage policy for an employer or for an industry to enter into an agreement providing for a yearly wage increase of a fixed proportion equivalent to the average annual percentage in productivity of past years. Such an annual improvement factor is based on the assumption that these past increases in productivity will continue in future. That this is an unrealistic assumption is demonstrated by the record of productivity change in individual industries and in the manufacturing sector as a whole. Productivity is neither automatic or continuous, thus the use of productivity in an

TABLE X

CHANGES IN PRODUCTIVITY - REAL WAGES
MANUFACTURING INDUSTRIES
1946 - 1964

INDUSTRY	Real Wages: Total Change as a Percentage of 1946	Real Wages: Average Yearly Change %	Rank	Productivity: Total Change as a Percentage of 1946	Productivity: Average Yearly Change %
Non-metallic Minerals and Products of Petroleum & Coal	76.30	4.02	1	91.31	4.81
Printing & Publishing	74.39	3.92	7	46.71	2.46
Chemical	74.11	3.90	2	82.38	4.33
Paper Products	73.08	3.85	11	40.47	2.13
Textiles	64.93	3.42	4	68.65	3.61
Iron & Steel	59.88	3.15	6	49.60	2.61
Non-ferrous Metals & Electrical Appliances	59.30	3.12	8	44.83	2.36
Miscellaneous Manufacturing	56.63	2.98	9	43.47	2.29
Foods & Beverages	55.01	2.90	10	41.95	2.21
Tobacco, Rubber & Leather	55.82	2.89	3	76.33	4.02
Transportation Equipment	53.16	2.80	5	63.72	3.55
Wood Products	52.73	2.78	12	36.78	1.94
Clothing	27.30	1.44	13	34.20	1.80

annual improvement factor could well grant much more or much less than what is warranted in terms of actual production.

> It is the rate of increase of productivity in the whole economy rather than that of particular firms or industries that is relevant to wage determination. If productivity change in individual firms or industries were used as guides in those firms or industries the whole wage structure would soon be thrown completely out of kilter since there is wide dispersion in rates of productivity change.[7]

Since the linking of wage rates to productivity rates in individual industries presents difficulties one might suspect that the same would be true at the sector level.

> Any direct attempt to link the wage level to the gross national product presupposes a national wage policy. Ignoring the statistical difficulties faced by planners and administrators of that policy, and also ignoring the impact of forces outside Canada upon it, one may question whether either management or labour would welcome such control. Both would be required to surrender freedom of action in the field of collective bargaining, freedom which they consider vital to their continued existance.[8]

As further result of such action would be to freeze the present distribution of income. There is little evidence to support the contention that organized labour is willing to accept a perpetuation of the present distribution of income.

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7 Ibid., p. 45.

8 James C. Cameron and F. J. L. Young, Productivity and Wages, (Bulletin No. 16; Kingston: Department of Industrial Relations, Queen's University, 1958), p. 19-20.

In addition to the problems already mentioned it must be emphasized that productivity is not the sole factor which influences wage agreements. S. H. Slichter[9] states that the following factors also influence the bargaining process:

a) the minimum necessities of workers;
b) changes in the cost of living;
c) maintenance of take-home pay in the face of reductions in hours;
d) the ability of the employer to pay;
e) the effect of the wage settlement on consumer purchasing power and employment;
f) wages paid in other industries or places;
g) the relative strength of the bargaining parties.

These difficulties notwithstanding, productivity remains an important factor in this area because at any given time the amount of real wages available to a particular group can be increased by only two methods. Either the share of another group or factor of production is appropriated, or the supply of goods and services may be increased through improvements in productivity.

Assuming that a suitable technique of measurement can be derived J. W. Kendrick and others have suggested that while the index of productivity should not be used as the sole determinant of wages

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9 Sumner H. Slichter, Basic Criteria Used in Wage Negotiations, (Chicago: The Chicago Association of Commerce and Industry, 1947).

in collective bargaining it could be used as an important bench mark designating the general area in which wage determination should take place.

> Withought dictating the form or amount of wage changes, this approach would force both parties at the barggaining table to consider the total impact of their decisions, not merely particular details. It would emphasize the general interest of the nation in short term economic stability with long term improvements in real income being linked to improvements in productivity. [10]

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10 Cameron and Young, Op. Cit., p. 24.

SUMMARY AND CONCLUSIONS

> Productivity deserves the attention that it has received, for it is a measure of the efficiency with which resources are converted into the commodities and services that men want. Higher productivity is a means to better levels of economic well-being and greater national strength. Higher productivity is a major source of the increment in income over which men bargain and sometimes quarrel. [1]

The primary purpose of this thesis has been to derive and analyse estimates of total factor productivity for the Canadian manufacturing sector. In the course of this study it has been necessary to assemble and analyse a great deal of information on the three basic building blocks of "total factor" productivity, i. e., output, labour and capital.

Real output in manufacturing as measured by the index of industrial production increased by 121 per cent over the 1946 - 1964 period. This growth of output was unevenly divided among the various industries and resulted from the four major expansions which characterized the period.

The first expansion was based on satisfying the backlog of war-deferred investment, consumer demand and on supplying the needs of the war-devastated countries. The second was based on the demand

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1 S. Fabricant, Basic Facts on Productivity Change, Occasional Paper 63, (New York, National Bureau of Economic Research, 1959), p. 1.

created by the outbreak of the Korean War and on the stock-pilling requirements at home and abroad. The third was the investment boom of the mid-fifties which was based on raw materials exploration and development. The last surge in demand and production was that which had its begining in the latter part of 1961 and which has extended itself to the present. These strong demand influences combined to make most of the period one of fairly rapid and sustained growth.

The proportion of the total labour force employed in the manufacturing sector has remained relatively stable over the period under consideration, though there have been some substantial shifts in the types and distribution of employment. The trend has been towards an increasing proportion of salaried workers in all industries which gives evidence of the growing importance of the marketing and managerial functions in modern industry.

Other developments which characterized the period have been a significant shortening of the work week and steadily increasing wages and salaries. In general, the earnings of salaried employees were higher and rose faster than did those of production workers. This disparity may have been in part due to the inclusion of executives in the salary estimates.

In the manufacturing sector, the stock of fixed reproducible capital in terms of 1949 dollars rose from $7,433 million in 1946 to $17,558 million in 1964. This increase in capital stock was in no way equally shared by all industries nor is the distribution of types of capital the same in all industries.

One of the major developments in this area during the period under consideration has been the change in emphasis in the distribution of expenditures on new capital. Prior to 1958 there was little change in the distribution of investment expenditures, thereafter, expenditures on machinery and equipment began to account for an ever increasing share of total new capital expenditures.

With respect to the estimates themselves it was found that between the 1946-1964 terminal years, productivity in the manufacturing sector increased by 51.4 per cent. This percentage increase over the rate prevailing in 1946 is equivalent to an average annual increase of 2.71 per cent. [2] Since real output, as measured by the index of industrial production increased by 121 per cent over the same period,

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2 This is a simple annual average rate of increase. On a compound basis the rate will be 2.73 per cent per annum.

or by an average of 6.4 per cent per year, it is evident that about two thirds of the growth in output was accounted for by additions to labour and capital while one third was contributed by increases in the efficiency with which the inputs were utilized i.e. productivity.

In the course of the analysis of the manufacturing sector the influence of cyclical fluctuations were investigated. It was determined that in general these forces tend to have a reinforcing effect. The years which recorded the greatest increase in productivity in general corresponded to the years in which output rose at a higher than average rate. On the other hand, the poorer productivity performances frequently coincided with periods where the growth of output was less than the average for the period.

The industry rates of productivity change, while tending to cluster about their mean, which coincides with the sector estimate, showed a considerable rage of dispersion. The industries which comprised the manufacturing sector have recorded productivity increases which vary from 34.2 to 91.3 per cent over the 1946-1964 period. The average annual rate of productivity increases range from 1.80 per cent in the Clothing industry to 4.81 per cent in the Non-metallic Minerals and Products of Petroleum and Coal industry.

While these two rates change bracket the dispersion of the different industries, it should be noted that the productivity rates of the majority of industries closely parallel that of the manufacturing sector as a whole.

As regards productivity and real wages it was established that generalizations on the basis of so short a period are difficult to make. Nevertheless it can be stated that the movements of the two variables while they exhibited marked variations in detail they both confirm the same general trend toward an improvement of a similar magnitude. The analysis has shown that over much of the 1946-1964 period the gains in real wages and salaries in manufacturing have been greater than those in productivity.

As regards the individual industries the record reveals considerable diversity. These differences should not be interpreted as negative correlation rather they should be viewed as evidence of the fact that there are many forces involved in the determination of wages in each individual industry. It was also noted that there seemed to be a relatively close correspondence between the industries with high productivity and those with high wages.

A great deal of work remains to be done in the field of productivity research. Initially, the public should be educated as to the exact meaning of productivity for "Productivity has been much discussed years, and too frequently misunderstood". [3]

Along with the explanation of the meaning of productivity some research is needed to improve the methods of calculating productivity and improving the quality of the input data.

Another area that could be profitably explored is that which the Economic Council of Canada is at present studying, i. e. the determinants of productivity. Once these factors have been isolated policies can be formulated which will improve this country's performance in that area. Finally, the relationship of productivity to costs, prices, profits, output, employment, investment and inflation should be studied if we are to gain a greater understanding and control over the workings of our economy.

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3 Ibid., p. 1.

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MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Food and Beverage Industry		Tobacco, Rubber and Leather Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	456	476	136	70
1947	490	509	143	78
1948	523	558	147	87
1949	549	598	149	93
1950	571	620	151	95
1951	590	641	152	95
1952	606	666	155	96
1953	620	696	157	103
1954	636	738	161	112
1955	658	783	164	122
1956	677	827	167	132
1957	694	874	171	144
1958	714	919	175	154
1959	736	963	177	163
1960	760	1016	181	172
1961	802	1114	185	187
1962	843	1215	188	196
1963	880	1224	192	209
1964	918	1323	199	223

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Textile Industry		Clothing Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	222	243	139	59
1947	230	260	138	66
1948	235	287	139	74
1949	237	311	140	82
1950	239	325	141	88
1951	241	340	142	92
1952	243	359	141	99
1953	243	369	141	107
1954	243	372	141	113
1955	242	378	140	118
1956	240	390	139	122
1957	236	399	132	128
1958	229	406	118	133
1959	222	413	100	138
1960	218	417	90	144
1961	221	429	91	152
1962	223	447	89	160
1963	228	467	89	170
1964	241	501	89	180

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Wood Industry		Paper Products Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	309	182	753	406
1947	309	189	786	415
1948	310	202	815	438
1949	313	216	838	458
1950	316	222	856	470
1951	320	228	878	506
1952	324	243	904	558
1953	328	254	920	611
1954	327	267	931	668
1955	324	286	944	734
1956	327	308	978	838
1957	318	329	1020	969
1958	304	345	1040	1069
1959	299	364	1045	1129
1960	297	387	1050	1196
1961	309	429	1070	1311
1962	316	475	1089	1423
1963	323	526	1108	1565
1964	334	584	1145	1747

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Printing and Publishing Industry		Iron and Steel Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	118	177	456	419
1947	122	177	471	427
1948	128	183	485	446
1949	133	191	496	464
1950	137	198	502	470
1951	141	208	520	486
1952	144	216	547	540
1953	145	216	566	607
1954	149	221	576	667
1955	154	230	581	720
1956	156	238	587	793
1957	163	248	597	882
1958	171	256	601	949
1959	178	261	604	1014
1960	182	268	616	1103
1961	187	283	657	1260
1962	193	298	681	1351
1963	202	317	714	1475
1964	213	339	761	1640

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Transportation Equipment Industry		Non-ferrous Metals and Electrical Apparatus Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	396	295	445	476
1947	399	272	451	456
1948	401	250	458	453
1949	404	246	466	464
1950	404	251	474	478
1951	402	263	491	496
1952	401	285	526	527
1953	404	316	566	566
1954	404	355	595	607
1955	401	388	622	653
1956	384	410	665	710
1957	383	439	718	778
1958	374	459	762	837
1959	376	476	789	870
1960	384	494	808	898
1961	399	525	830	970
1962	412	559	851	1017
1963	434	605	873	1030
1964	463	668	901	1073

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

	Non-metallic Minerals, and Products of Petroleum and Coal Industry		Chemical Industry	
Year	Construction	Machinery and Equipment	Construction	Machinery and Equipment
1946	447	140	383	127
1947	464	154	399	138
1948	498	181	414	162
1949	524	202	427	186
1950	537	216	435	202
1951	551	250	445	220
1952	575	297	476	266
1953	612	336	511	334
1954	669	363	526	380
1955	746	386	538	400
1956	832	422	564	444
1957	923	468	603	503
1958	1016	496	636	553
1959	1104	525	655	594
1960	1172	557	666	636
1961	1223	603	687	718
1962	1300	661	706	778
1963	1338	721	725	838
1964	1362	786	749	923

MANUFACTURING INDUSTRIES
ESTIMATES OF TOTAL GROSS FIXED CAPITAL STOCKS
MILLIONS OF CONSTANT 1949 DOLLARS
1946 - 1964

Year	Miscellaneous Manufacturing Industry Construction	Machinery and Equipment
1946	57	28
1947	58	30
1948	60	32
1949	62	35
1950	64	36
1951	66	37
1952	68	39
1953	70	41
1954	71	43
1955	72	45
1956	73	49
1957	74	54
1958	74	59
1959	72	63
1960	73	67
1961	77	74
1962	82	84
1963	87	84
1964	94	102

Source: Data on gross capital stock for the period 1946-1960 were taken from "Preliminary Estimates of Fixed Capital Flows and Stocks, Canada, 1946-1960", DBS Daily Bulletin Supplement-2, Tuesday December 22, 1964. The estimates of gross capital stock for the 1961-1964 period were produced by the author using the method outlined in Chapter IV of this thesis.

APPENDIX 2

INDEXES OF TOTAL FACTOR PRODUCTIVITY
CANADIAN MANUFACTURING INDUSTRIES
1946 - 1964
(1949 = 100.0)

Year	Food & Beverage Industry	Tobacco, Rubber & Leather Industry	Textile Industry	Clothing Industry
1946	104.1	102.1	102.8	107.2
1947	104.8	111.3	107.2	104.2
1948	101.7	105.4	102.1	100.8
1949	100.0	100.0	100.0	100.0
1950	104.2	108.4	111.1	103.5
1951	106.8	106.3	113.9	109.8
1952	112.8	115.0	117.8	115.9
1953	113.4	121.4	116.3	116.5
1954	114.9	122.3	110.2	119.6
1955	118.8	132.7	122.9	120.5
1956	122.5	139.1	132.5	125.5
1957	120.5	140.9	130.1	125.4
1958	124.4	145.1	126.8	126.0
1959	127.4	153.3	140.2	123.3
1960	129.0	145.5	140.3	119.6
1961	127.0	154.9	152.8	116.3
1962	136.3	160.9	158.4	117.8
1963	139.5	170.9	167.2	146.1
1964	147.7	180.0	173.4	143.8

INDEXES OF TOTAL FACTOR PRODUCTIVITY CANADIAN MANUFACTURING INDUSTRIES 1946 - 1964 (1949 = 100. 0)

Year	Wood Industry	Paper Products Industry	Printing & Publishing Industry	Iron & Steel Industry
1946	103. 4	93. 1	92. 0	92. 0
1947	104. 1	97. 1	97. 4	99. 2
1948	101. 1	97. 7	101. 0	99. 0
1949	100. 0	100. 0	100. 0	100. 0
1950	106. 2	108. 4	101. 4	104. 2
1951	110. 9	113. 4	104. 6	111. 0
1952	111. 1	106. 3	106. 4	105. 6
1953	115. 1	111. 1	109. 5	102. 2
1954	118. 3	115. 0	113. 2	100. 5
1955	122. 5	118. 3	115. 0	112. 1
1956	121. 1	119. 1	121. 7	122. 3
1957	119. 1	115. 4	119. 6	116. 6
1958	125. 8	114. 1	115. 5	114. 9
1959	129. 3	119. 8	119. 5	123. 4
1960	129. 5	119. 9	119. 8	121. 9
1961	134. 2	122. 8	123. 1	123. 8
1962	139. 7	124. 8	127. 8	127. 0
1963	140. 1	125. 6	128. 9	129. 0
1964	141. 4	130. 8	134. 9	137. 6

INDEXES OF TOTAL FACTOR PRODUCTIVITY
CANADIAN MANUFACTURING INDUSTRIES
1946 - 1964
(1949 = 100.0)

Year	Transportation Equipment Industry	Non-ferrous Metals & Electrical Apparatus Industry	Non-metallic Minerals, & Products of Petroleum & Coal Industry	Chemicals Industry
1946	85.8	91.1	87.6	99.1
1947	97.6	98.5	95.6	101.6
1948	98.0	99.2	97.1	101.6
1949	100.0	100.0	100.0	100.0
1950	107.9	105.4	107.2	109.9
1951	119.0	105.9	118.1	113.7
1952	110.8	101.8	116.5	109.9
1953	109.3	107.7	121.7	116.5
1954	106.5	105.3	124.5	125.4
1955	117.0	116.2	134.0	132.4
1956	113.4	116.4	142.6	136.0
1957	105.2	109.4	139.1	137.0
1958	98.5	109.0	138.3	144.6
1959	108.3	116.5	142.4	150.9
1960	109.7	121.9	140.7	156.5
1961	112.5	123.8	145.3	160.9
1962	127.0	130.1	147.9	162.4
1963	138.2	133.3	153.9	168.4
1964	140.4	132.0	167.6	180.6

INDEXES OF TOTAL FACTOR PRODUCTIVITY
CANADIAN MANUFACTURING INDUSTRIES
1946 - 1964
(1949 = 100.0)

Year	Miscellaneous Manufacturing Industry	Manufacturing Sector
1946	99.2	96.4
1947	96.4	101.1
1948	96.5	100.0
1949	100.0	100.0
1950	102.0	105.9
1951	111.7	110.3
1952	109.3	109.5
1953	106.1	111.7
1954	115.0	112.2
1955	113.6	119.5
1956	114.5	123.3
1957	115.9	119.8
1958	120.1	119.9
1959	124.1	125.9
1960	129.1	126.3
1961	133.4	129.0
1962	144.7	134.9
1963	140.9	140.8
1964	142.3	145.9